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AMERICAN MUSEUM NOVITATES

NUMBERS 347 TO 400

THE
AMERICAN
MUSEUM
OF
NATURAL
HISTORY
SCIENCE
EDUCATION

NEW YORK
PUBLISHED BY ORDER OF THE TRUSTEES
1929-1930

EDITED BY

ETHEL J. TIMONIER
CHESTER A. REEDS

THE AMERICAN MUSEUM OF NATURAL HISTORY

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ERRATA

No. **348.** Page 12, line 4 from bottom: for *Hynobiuslich enatus* read *Hynobius lichenatus*.
" **353.** Page 2, top line: change the dash to a hyphen in Titanothere-bearing.
" **353.** Page 14, line 4 from bottom: change in to is.
" **354.** Page 16, line 21 from top: for palèocénes read paléocènes.
" **356.** Page 2, line 12 from bottom: for *Zosterops magillivrayi* read *macgillivrayi*.
" **364.** Page 6, line 20 from top: for April 4 read April 9.
" **364.** Page 10, lines 12 and 15 from top: for 1897 read 1879.
" **364.** Page 11, lines 8, 9, 14, 17, and 18 from top: for *metcalfei* read *metcalfii*.
" **364.** Page 14, transpose lines 15 to 33, inclusive, to p. 15, after line 8 from top.

No. **364.** Page 15, line 8 from top, for ♂, 40, 41; ♀, 39, 39, 40 mm. read. ♂, 20, 21; ♀ 19, 19, 20 mm.

" **364.** Page 15, line 17 from bottom: for 1918 read 1908.

" **368.** Page 20, line 13 from top: omit the letter s in the word forms.

" **370.** Page 17, top line: read *Pterodroma leucoptera* for *Petrodroma leucoptera.*

" **372.** Insert the following captions under Figs. 1 and 2.

Fig. 1. A greenockite crystal from West Paterson, drawn in ideal proportion.

" **372.** Fig. 2. A greenockite crystal from West Paterson, showing the twinning habit parallel to *z* ($11\bar{2}1$).

" **374.** Insert the following captions under Figs. 1 to 4:

Fig. 1. A gnomonic projection of the generalized form system of the danburite crystals from Obira, Japan.

Fig. 2. Enlarged gnomonic projection of a quadrantal portion of the form system of danburite crystals from Obira, Japan, showing new and rare forms.

Fig. 3. Front view of crystal No. 1, danburite, from Obira, Japan, drawn in actual proportion.

Fig. 4. Rear view of crystal No. 1, danburite, from Obira, Japan, drawn in actual proportion.

" **374.** Page 8, top line: for [No. 347 read [No. 374.

" **375.** Page 6, line 9 from bottom: for *Cænœia* species read *Cœnosia* species.

" **375.** Page 8, top line: for [No. 000 read [No. 375.

" **375.** Page 11, line 11 from top: for *irreguieta* read *irrequieta.*

" **375.** Page 11, line 2 from bottom: for figure 1 read figure 4.

" **375.** Page 12, line 7 from top: for differeing read differing.

" **375.** Page 12, line 22 from bottom: for *Caledonia petiola*, new species, read *Caledonia petiolata*, new species.

" **376.** Page 5, line 3 from bottom: omit the word do.

" **376.** Page 8, line 3 from top: for No. 21701 read No. 21732.

" **385.** Page 12, line 4 from bottom: for expeditions read explorations.

" **388.** Page 2, line 16 from top: for oradually read gradually.

" **391.** Page 2, line 6 from bottom: for In *callarti* read In *collarti.*

" **392.** Page 7, line 6 from bottom: for Uucinus read Uncinus.

" **393.** Page 16, line 6 from bottom: Fig. 16 *Stegolophodon*, etc., read *Stegodon.*

" **394.** Page 6, line 5 from top: for in read is.

" **396.** Page 2, line 15 from top: for Novbemer read November.

" **397.** Page 4, line 21 from bottom: for *Hoplites mensæ* read *Hoplites mesæ.*

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AN MUSEUM NOVITATES

347 Published by
The American Museum of Natural History
New York City April 27, 1929

59 79L 15 6

THE BREEDING HABITS OF TWO SALAMANDERS

By G. K. Noble and B. C. Marshall

In September, 1927, we visited the Ozark Mountains of south- tern Missouri to study *Typhlotriton spelæus* in the field and to col- ct a series for an experimental investigation of the causes of eye egeneration in this species. The field work was continued by one f us, Marshall, throughout a part of 1928. In the course of the work larshall made observations on the breeding habits of two other species urodeles. The observations on one species, *Ambystoma annulatum*, e different in nearly every detail from the facts previously published, hile no information concerning the breeding habits of the other ecies, *Plethodon glutinosus*, has been published.

Ambystoma annulatum Cope

On the afternoon of September 30, 1927, Marshall, with our ude, John Powell, investigated the report that great numbers of animals had invaded a cistern in a sweet potato patch owned ss Sims, between Reed's Spring and Marvel Cave, Stone Co., souri. The month of September had been fairly dry but it had ed the same morning In the cistern were found ten adult speci- ns of *Ambystoma annulatum* swimming near the surface and these re readily caught with a long-handled dip-net. The salamanders st have burrowed into the cistern from under the curbing as the p of the cistern was tightly covered and further, the curbing was roximately two feet high. The owner of the cistern was unable fer any other explanation as to how the salamanders might have ed entrance to the water. The sweet potato patch was about n yards from the cistern. Some of the sweet potatoes had been p and the vines left in piles on the ground. Under these wither- ines several more adult specimens were found. In a few in- s four or five salamanders were huddled together under one Approximately thirty yards below the sweet potato patch ll body of water known as Ghost Pond. Along the edge of 150 may w more salamanders were found under the débris of brush or leaves. Eggs were everywhere abundant in the pon were attached to water-plants but the greater number were i criminately spread over the whole bottom of the pond. The e were found to be in different stages of development but no larvæ from the egg-capsules were obtained even after considerable scoopi with the dip-net. Two or three adult *A. annulatum* were brough up in the net, with the eggs. The pond was round, four or five hu dred feet in diameter and approximately waist-deep in the cent It must have contained many thousand eggs.

Although no salamanders were seen to lay the eggs, there can little doubt but that they were laid by this colony of *A. annulatun* No eggs were found on land where the salamanders were hiding. Th pond was low, for there had been little rain and certainly not sufficie that morning to have caused a sudden rise. It was impossible fo the eggs to have been laid on land and later flooded or to have bee washed into the pond from the bank. Their great number, the wide distribution over the bottom of the pond and the few attac to water-weed definitely established this fact.

There are few ponds in the southern part of Stone County. Th region is largely limestone and the rain-water which falls quick runs off into the subterranean water-channels. There is, neverthele a more or less permanent body of water near Marvel Cave on Lynch property. During September the pond was about t dred feet wide. We collected along its boggy shores on several o sions during September without finding any salamanders. On Oct 8 a very thorough search of this pond was made but not a single or salamander of any species was found.

Our previous knowledge of the breeding of *Ambystoma annulatu* rests entirely on the observations of Combs as reported by Streck (1908). "One night in March after a severe rainstorm" Combs visit a log near Hot Springs, Arkansas, under which he had previ collected two adult *A. annulatum*. On turning the log over he fo two additional adults, one of which had already deposited thirty- eggs in the mud under the log. The salamanders were placed in "half full of mud and water." In twelve hours they had dep a total of one hundred and fifty eggs. "On the fifth day th began to shrivel up" and when Combs poured more water in t they "resumed their normal condition." On the tenth day t began to hatch.

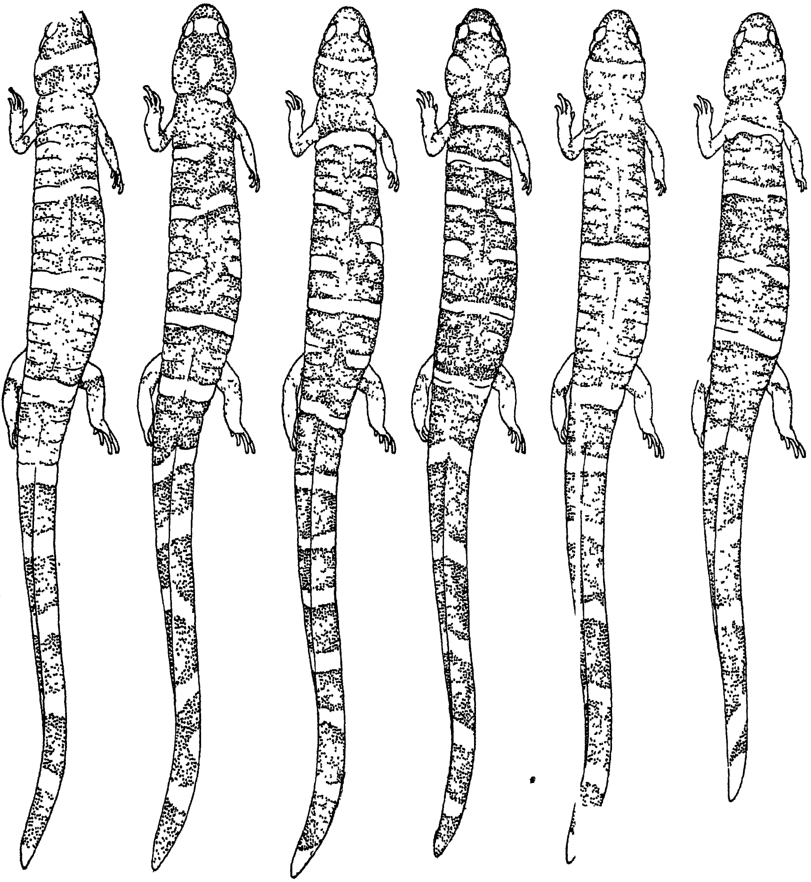

Fig. 1. Color variation in *Ambystoma annulatum.*

From this data Strecker (1908) concludes in part, in regard to *A. annulatum:*

(1) These salamanders inhabit the deserted burrows of crayfish and only come to the surface when the ground is moist.

(2) They deposit their eggs on the ground, under logs or among masses of decayed wood.

(3) The female keeps her eggs supplied with moisture until they are hatched. I have no doubt but what she carries them down into the ground, to the line of moisture, in exceedingly dry weather.

(4) The eggs are never in strings, but are always separate, and as many as 150 may be deposited by the same female.

These conclusions are so completely at variance with given above that it would seem that the species considered mus different. We have before us a large series of specimens collected from the Jess Sims farm and have compared them with the type, U. S. N. M. No. 11564. In this specimen there are five cross-bands or rings between the anterior and posterior pair of legs and the first and third rings are incomplete dorsally. In our series there are several specimens identical with the type but others show a wide range of variation. In figure 1 we have shown the range of variation exhibited by the males. The females were equally variable and showed no constant color difference from the males. In no specimen were all the cross-bands divided into blotches. The least-banded specimens were a pair of opposite sex, each specimen having only two complete and one incomplete cross-bands between the anterior and posterior legs. It is clear that the species is more variable in color pattern than previously assumed.

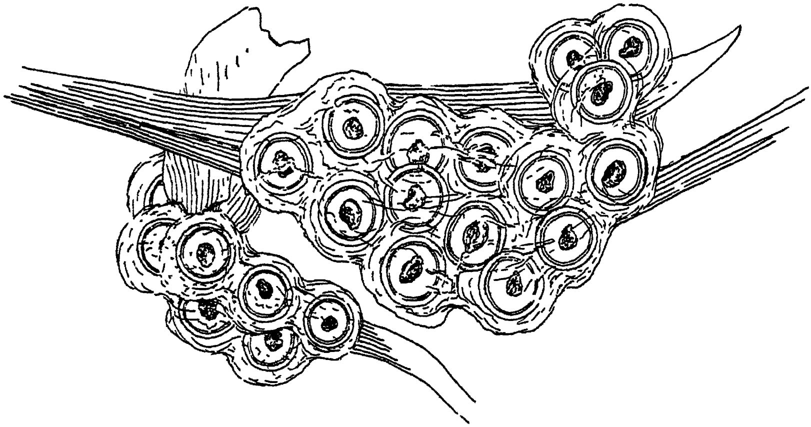

Fig. 2. The eggs of *Ambystoma annulatum.*

The eggs of *Ambystoma annulatum* were preserved in jars of formol and no detailed observations made concerning them until later in the laboratory. Some of the egg-masses were probably broken in shipment. All the eggs except one are in bunches. These vary considerably in the number of eggs they include. Of the series preserved in the American Museum there are three bunches of two eggs each, five of three, three of four, one of five, one of five attached by a single egg

..other of five, one of six, two of seven, one of seven attached by a small strand to a bunch of twenty-six, one of ten, one of eleven, one of eleven attached to a bunch of twenty-one eggs, one of eleven attached to thirteen, two of twelve, one of thirteen, three of fourteen, one of fifteen, two of sixteen, one of twenty-one, and one of forty-five eggs. From these data it may be concluded that the eggs of *A. annulatum* are usually laid in bunches of at least ten eggs but usually of not over forty-five.

As shown in figure 2, each bunch is enclosed in a single gelatinous capsule which is so thin that the contour of each egg is more or less preserved. Exclusive of this common capsule each egg is surrounded by two capsules and a thin adherent vitelline membrane. The inner of the capsules is clearly differentiated, for in the preserved specimens both its inner and outer surfaces are finely crenulated and slightly discolored. The common capsule covering an average egg is 8 mm. in diameter, the outer of the two egg-capsules 5 mm. in diameter, the inner 4.4 mm., while the egg itself is 2 mm.

During the late blastula stage a third of the egg of *A. annulatum* is heavily pigmented. As gastrulation proceeds the color becomes a paler brown more uniformly distributed over the embryo. The latest stage in the preserved series in the American Museum is that of an embryo with the branchial and hyoid arches marked out as feeble ridges. A prominent protuberance, the rudiment of the balancer, is present on each mandibular arch. At this stage the embryo is nearly uniform brown both above and below, 7 mm. in total length and with a tail a trifle less than a millimeter long.

The eggs and embryos of *A. annulatum* as described above agree most closely with those of *A. jeffersonianum* as detailed by Piersol (1910) and Smith (1911). The points of agreement are:

(1) Eggs small. They average smaller than those of *A. jeffersonianum* which are smaller than eggs of *A. maculatum* and of *A. tigrinum.*

(2) Eggs well pigmented. They are not as dark as those of *A. jeffersonianum,* but darker than preserved eggs of *A. tigrinum.*

(3) Common envelope of egg-cluster thin, the contour of the individual eggs distinct. This is perhaps the most conspicuous point of agreement with *A. jeffersonianum.*

(4) Egg-clusters small and scattered, the eggs not forming a compact group.

(5) Number of eggs to cluster small. *A. jeffersonianum* averages twenty (Piersol) or fourteen (Smith) to a cluster and this agrees very well with *A. annulatum.*

(6) A balancer is present as in *A. jeffersonianum* and *A. maculatum.* It is usually absent in *A. tigrinum.*

The chief point of disagreement between the breeding p in *A. annulatum* and in *A. jeffersonianum* is that the latter species breeds in the early spring and the former, according to our observations but not those of Combs, after rains in the fall. We shall discuss this discrepancy in greater detail below.

Plethodon glutinosus (Green)

The eggs of the slimy salamander have not been previously described although the species is one of the more common forms of eastern United States. Okey (1916) briefly mentioned the eggs and larvæ of the species, but as larvæ later sent to one of us from the laboratory where Okey studied proved to be not *P. glutinosus* as labeled but *Ambystoma microstomum* we may safely assume that Okey's material was also referable to the latter species.

On August 17, 1928, Marshall found for the first time the eggs of *P. glutinosus*. They were taken in Sheridan Cave, near Mountain Home, Arkansas. The eggs were hanging suspended from a perpendicular wall forming the back of a pocket in the cave wall about four feet above the floor of the cave. The pocket was approximately eight inches long by six inches high and six inches deep. It was near the entrance to the cave. The eggs which were in the cleavage stages were accompanied by a large female, 162 mm. in total length and 75 mm. head and body-length. The female was resting on the floor of the pocket under the eggs. The cave was thoroughly searched but yielded in addition only two immature *P. glutinosus* and three adult *Eurycea melanopleura*.

On September 3, of the same year, an additional set of eggs of *P. glutinosus* was found. These were discovered in Indian Cave, near Bella Vista, Arkansas. They were lying in the bottom of a small crevice in the wall of the cave about three feet above the floor and two hundred feet from the entrance of the cave. The eggs contained well-developed embryos. No adult was found with them but two immature *P. glutinosus* were found in other parts of the cave. The only other salamander found in the cave was a larva of *Typhlotriton spelæus*.

There are eighteen eggs in the first bunch collected and only ten in the second. The eggs are not stalked but held together in a single gelatinous envelope. This common envelope is clearly shown in both bunches of eggs but particularly in the earlier set where the eggs have been little damaged in transportation. We include a figure of two of ggs from the older series (Fig. 3) which shows the outer envelope as well as the underlying inner egg-capsules.

Except for the absence of a stalk, the eggs of *P. glutinosus* agree closely with those of *P. cinereus* as described by Piersol (1910*a*). There are two clusters of eggs of *P. cinereus* in the collections of the American Museum. One includes seven and the other eight eggs. Neither shows the egg-membranes clearly and we quote from Piersol (p. 475) concerning these structures in *P. cinereus:*

> In their natural condition the number of these is rather difficult to determine but after soaking a few minutes in water they swell somewhat and the following is plainly seen:—an innermost sphere very close to the surface of the egg; a second enclosing this but separated from it by a greater interval than that between the innermost sphere and the egg; occasionally this sphere is represented by two, one of them fitted very closely around the other. The outermost sphere—usually the third—fuses with the outermost spheres of neighboring eggs at all points of contact. On its surface are threads and bands of a milky white mucus which seem tougher than the rest, which is transparent; these are especially numerous between eggs and at the upper part of the bunch where several uniting form the stalk by which the cluster is suspended.

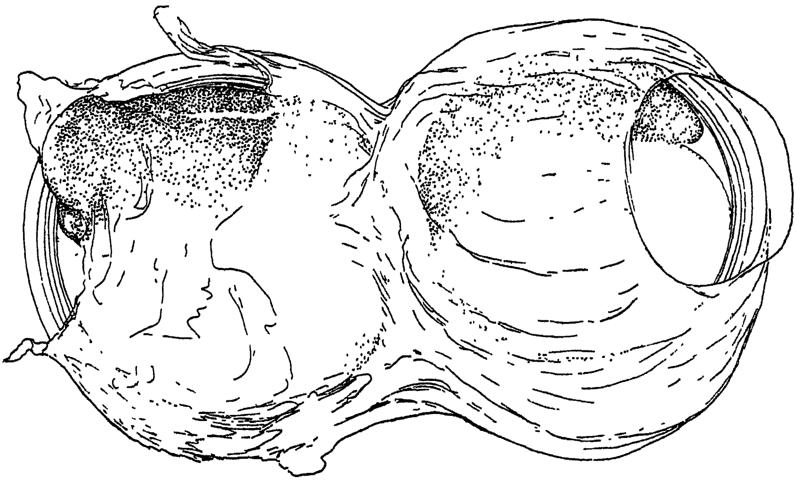

Fig. 3. Two eggs of *Plethodon glutinosus*, the outer capsule broken at two points showing the inner egg-capsules.

In both sets of *P. glutinosus* eggs the same envelopes may be recognized. There is a thin adherent vitelline membrane, and a rather thick egg-capsule surrounding it. This egg-capsule may be divided into several layers. In the earlier and better preserved eggs it is divided into an inner and an outer capsule, the latter not as as the former In the older and in some of the younger eggs the inner of these two capsules may be divided again into several layers We have figured a case where the inner capsule has three distinct layers (Fig 3) It is not unlikely that fresh eggs will be found to have only two layers to this capsule, as in *P cinereus* but, as most descriptions are based on formalin preserved eggs it is important to stress this tendency of the inner egg-capsule to be subdivided in preserved material Surrounding the outer egg-capsule is the common envelope described by Piersol (1915) as the outermost sphere in *P cinereus* Piersol's terminology has in its favor his observations that each egg is laid separately and later the outer sphere fuses to that of the neighboring eggs In preserved material of *P glutinosus* the outer spheres of the eggs are completely fused and form a common outer envelope as in *Ambystoma annulatum*

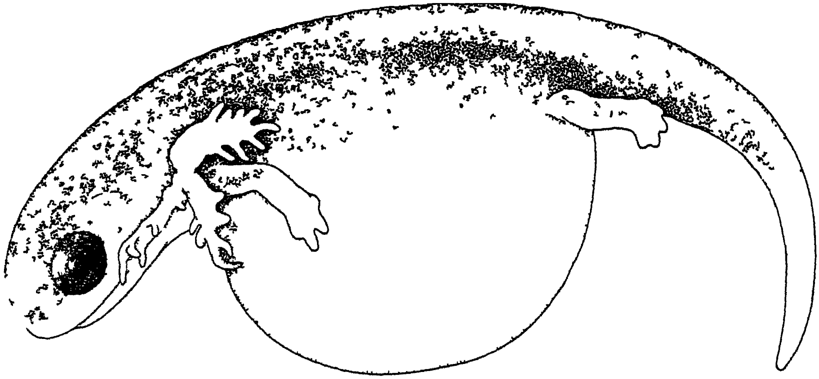

Fig 4 Embryo of *Plethodon glutinosus*

An average egg of *P glutinosus* measures 5 5 mm in diameter It is creamy white in color Its vitelline membrane measures only a fraction of a millimeter more than the diameter of the egg The inner of the two surrounding egg-capsules measures 6 mm in diameter, the outer 6 5 mm The common envelope or outer sphere of Piersol measures 7 5 mm in diameter in this egg but it is somewhat variable in thickness about the other eggs

The form of the embryos in the second set of eggs is shown in a figure of one of them (Fig 4) The antler-like gills are joined at their bases The embryos are well pigmented above with stellate melano-

These are most numerous along the sides of the body. A narrow vertebral line and a number of small spots scattered over head and back are for the most part devoid of pigment. A great many of the melanophores on either side of the pigmentless vertebral line have their processes extended transversely to the axis of the body, while on other parts of the embryo they exhibit an irregular radiate form. This suggests that these dorsal melanophores are migrating towards the sides of the body where the pigmentation is already greatest. Further, there would seem to be some mechanical obstruction underlying the epidermis to prevent their reaching the midline of the body or sending their processes across the small white spots. A histological examination would reveal the nature of these obstructions. It may be developing glands, rudimentary lateral line organs or other modifications of the integument. Such an examination might reveal the reason for the accumulation of pigment along the sides of the body. This region might be the region of maximum cutaneous respiration, of maximum skin growth or of both. It is idle to speculate as to the causes of color pattern in Amphibia until more facts have been presented. In the meantime it is interesting to note that *P. glutinosus* during its development should exhibit a striped pattern which is later obscured in this species but not in certain other species of the genus.

One of the embryos extended measures 16 mm. in total length. The yolk at this stage is 6.5 mm. in greatest length, and 5 mm. in width. Hence it has either swollen in fixation or during growth. The largest gill is 2.2 mm. long. The proportions of fingers, toes and other structures are shown in the figure of a second embryo (Fig. 4).

DISCUSSION

Our observations on *Plethodon glutinosus* are in accord with a thesis previously advocated (Noble, 1927) that the mode of life-history of an amphibian is usually good evidence of its relationships. *Plethodon glutinosus* is larger and more primitive than *P. cinereus.* Most large species have more eggs than their near relatives of smaller size. Piersol (1910*a*) gives the egg-number of *P. cinereus* as from three to twelve. Our egg-clusters of *P. glutinosus* included ten and eighteen eggs respectively. As the former cluster of *P. glutinosus* lacked a guarding female it is barely possible that some animal may have destroyed the female and devoured a few of the eggs. Their position on the floor of the crevice would support this view although Piersol (1915) has recorded a case of unattached eggs in *P. cinereus.* The most distinctive feature of the larger cluster of eggs was the absence of a stalk of atta Hence it is possible that *P. glutinosus* might not always attach eggs to an overlying surface. Piersol (1915) has sketched an evolutionary series in the egg-capsules of urodeles. We can not agree with him that egg-capsules of *Autodax* have evolved directly from those of a *Eurycea* type. As pointed out elsewhere (Noble, 1927), *Autodax* (=*Aneides*) has evolved from *Plethodon* and it has redeveloped the individual stalks for each egg. But these stalks are not attached to the underside of a rock as in *Eurycea.* The egg-cluster is laid on land as in *Plethodon,* and although the form of the capsule is more specialized than in that genus it may be derived from the *Plethodon* type by assuming that the gelatinous egg-capsule material was secreted between the times during which any two eggs were laid.

In concluding this discussion of *Plethodon glutinosus* the question might be raised as to where one might expect to find the eggs of the species in regions where no caves occur. In the immediate vicinity of Imboden, Arkansas, no caves are found. Very young individuals (the smallest 32 mm. total length) of *P. glutinosus* have been taken among the moist gravel of springs. A young individual 66 mm. in total length was taken under a stone in a spring outlet near Plainfield, New Jersey. Larger specimens of *P. glutinosus* are usually not found in such situations either at Imboden or Plainfield. Hence, it seems to us possible that the adults penetrate into the ground for some depth to lay their eggs and the young, in seeking the outer world, follow crevices such as those formed by ground-waters and make their exit on occasions near springs.

Turning to *Ambystoma annulatum* it may be asked, how may we account for the great discrepancy between the description of the eggs of *Ambystoma annulatum* given by Combs and that recorded above? Strecker's (1908) report of Combs' description is so detailed that we believe there is little chance of Combs having made an error. Rather it seems to us that we have in *Ambystoma annulatum* a species which usually lays its eggs in the water and conforms to the breeding process characterizing most species of the genus. Under some circumstances it is able to lay its eggs on land and if the eggs are given sufficient moisture development will proceed. This suggestion is rendered plausible by the observations of Brimley (1921) on *Ambystoma maculatum.* It is well known that the species usually lays its eggs in the ponds in the spring. Brimley recorded one case of eggs of this species laid in February "among wet dead leaves lying just above the level of the beneath a dead log which lay pa in and part out of the water. The albumen around these eggs had swollen up into an irregular mass around each egg, but each egg was distinct and not united to any other, thus the group presented an intermediate stage between the normal condition of the eggs of *maculatum* and that of *opacum*."

In this connection it would be interesting to know if *A. opacum* might not under certain circumstances deposit its eggs in the water. This flexibility of choice of the breeding site, if it could be established, would be detrimental in no way to the thesis advocated as to the stability of the mode of life-history. As previously pointed out (Noble, 1927, p. 45), *A. opacum* agrees essentially in its mode of development with other species of *Ambystoma*. The observations on *A. annulatum* are of interest in showing how flexible the choice of egg-laying site may be in a species which has no terrestrial adaptations in its larval organization.

CONCLUSIONS

(1) *Ambystoma annulatum* lays its eggs in water after rains in late September.

(2) The eggs and embryos agree essentially with those of *A. jeffersonianum*.

(3) The previous report of *A. annulatum* laying eggs on land suggests that the species is flexible in the choice of an egg-laying site.

(4) *Plethodon glutinosus* lays its eggs in late summer in caves in northern Arkansas. The eggs and embryos agree essentially with those of *P. cinereus* except that there is no stalk of attachment for the egg-cluster and the egg-number averages greater.

(5) The egg-capsule number exhibits some variation in preserved material. At least two egg-capsules and a vitelline membrane are present. The inner egg-capsule is normally subdivided into two and frequently into more capsules.

(6) *P. glutinosus* passes through a poorly defined striped pattern during its ontogeny.

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AMERICAN MUSEUM NOVITATES

Number 348 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | April 29, 1929

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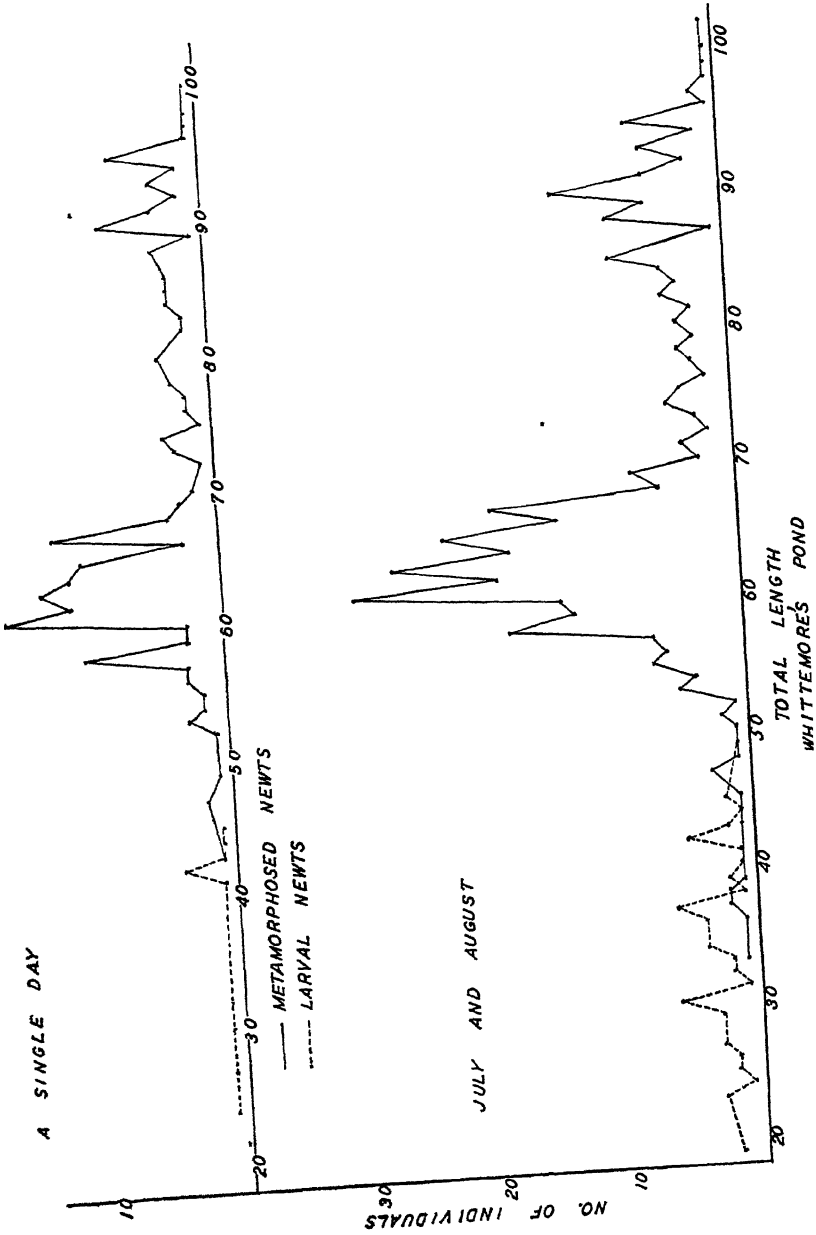
FURTHER OBSERVATIONS ON THE LIFE-HISTORY OF THE NEWT, *TRITURUS VIRIDESCENS*

BY G. K. NOBLE

In 1926 I pointed out that the newt *Triturus viridescens* Rafinesque does not always pass through a terrestrial red-eft stage as had been hitherto believed, since small aquatic newts collected on Long Island proved, on histological examination, to be sexually immature although metamorphosed. More recently Pope (1928) has discussed my conclusions which he says (p. 62) are "based upon local conditions on Long Island and do not apply to the greater part of the animal's range." The series of newts available to me was small and I was careful to emphasize that my data on the immature newt proved "merely that some sexually immature newts may be aquatic." Pope, in reviewing my paper, has raised a number of questions which it seems to me might be more profitably answered by considering the life-history of the newt in a mainland locality and thus avoid the objection that the material considered was physiologically even if not morphologically distinct from the material discussed by Pope. For this purpose I selected the Woods Hole region of Cape Cod, for during the past summer I enjoyed the privileges of investigator while at the Marine Biological Laboratory. My thanks are due to the Supply Department of the Laboratory in aiding me in collecting, to Mrs. L. Baker for technical assistance, and Mrs. E. M. Beutenmuller for the drawings made from my cleared preparations. The observations made at Woods Hole not only confirm but considerably extend the conclusions of my former paper

THE WOODS HOLE NEWT

The newt in the Woods Hole region seems to show a preference for certain ponds. It was found abundantly in Whittemore's Pond, a small body of water between the sand-dunes about a quarter of a mile inland of Racing Beach, but was not found at all in a smaller pool in the woods opposite Endicott Lodge. The bottom of the latter pool was covered, during my investigation, with a thick layer of rotting leaves. Thirty larvæ of *Ambystoma maculatum* were collected here and a few tadpoles


A SINGLE DAY
— METAMORPHOSED NEWTS
---- LARVAL NEWTS
JULY AND AUGUST
TOTAL LENGTH
WHITTEMORE'S POND
NO. OF INDIVIDUALS
10
30
20
10
20
30
40
50
60
70
80
90
100

of *Hyla versicolor.* Weeks' Pond, near the main road from Woods Hole to Falmouth, was only twenty to thirty feet wide at the time of my observations but it contained newt larvæ as well as the larvæ of *A. maculatum, Hyla versicolor, H. crucifer* and *Rana clamitans.* Newts, both larval and adult, were found in two large ponds known to the Supply Department as the "Mashpee Ponds" and lying within the town of Mashpee near the Falmouth border. No newts were found in the several other ponds visited near Mashpee and Falmouth. Fish may be responsible for the absence of newts from some of the larger ponds but not from the Endicott Lodge pond. The species was abundant in the much smaller body of water on the Weeks' property. The only unusual feature of the Endicott Lodge pond was the thick deposit of decaying leaves which would tend to render the waters more acid.

In discussing the life-history of the newt, Pope (1928) takes exception to my statement that Long Island newts "do not require more than one season as a metamorphosed individual to reach sexual maturity," although he presents no data to show when he conceives newts reach maturity as distinguished from full size. I have dissected the gonads of a large series of the newts collected near Woods Hole and have found very large testes in fourteen newts from Whittemore's Pond collected from August 8 to August 29, and measuring 51.3 mm. to 64 mm. total length (28 to 32 head and body-length). As shown in figures 1 and 3 of a graph of the sizes of the total population collected from this pond at the same time, this size range covers the first mode of our graph of metamorphosed individuals As the size at metamorphosis is known from a series of larvæ taken from Whittemore's Pond and metamorphosed in the laboratory to be approximately 32 mm. total length, there can be no interpretation other than that some Whittemore Pond newts, as some Long Islands newts, reach sexual maturity not later than one year after metamorphosis. The criteria of metamorphosis as used here include primarily the loss of body fin, the change of skin structure and color, and the transformation of the skull, exclusive of the hyobranchial apparatus.

The newts from the Mashpee ponds, as shown in graphs (Fig. 2 and 3), may reach a much larger size before metamorphosing (in the construction of all the graphs fractions have been increased or diminished to the nearest whole number). I have examined a series of fifteen larvæ measuring 56 mm. to 66 mm. total length which had greatly enlarged testes. In sections of the testis of one of these, measuring 61 mm. total length, and collected August 30, 1928, I found a large part of the tubules packed with

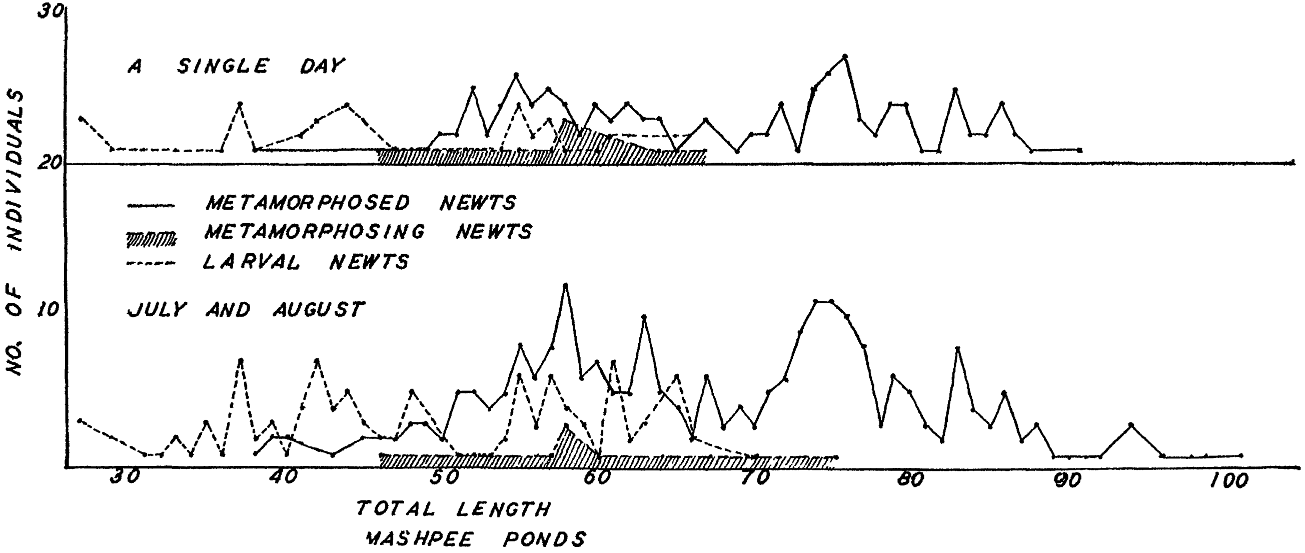


Fig. 2. Frequency graphs of larval, adult, and metamorphosing newts collected in two adjacent ponds in the Woods Hole region. The series collected in a single day compared with that collected during July and August.

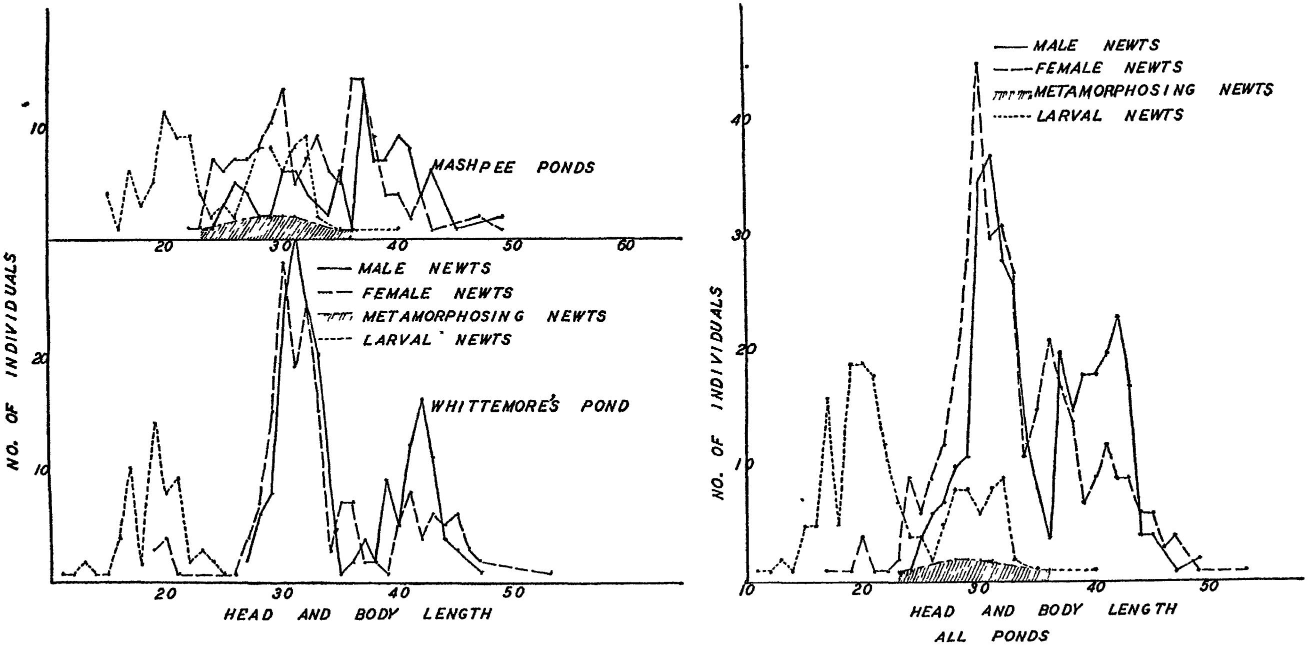


Fig. 3. Frequency graphs of newts from the Woods Hole region, head and body-lengths compared.

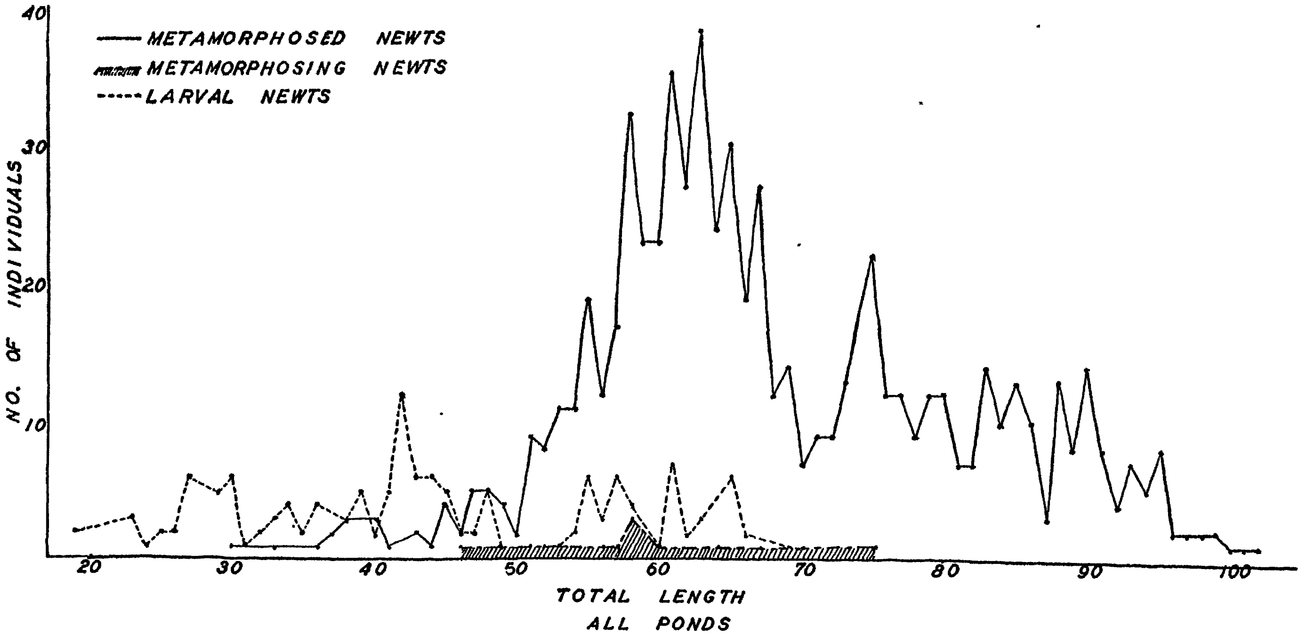


Fig. 4. Frequency graphs of newts from the Woods Hole region. The entire population collected in all ponds during July and August considered.

sperm. It is thus proved that some specimens of *Triturus viridescens* may reach sexual maturity while still larvæ.

Pope (1928) gives a lengthy discussion of the size at which newts metamorphose. He is unable to agree with me that Long Island newts probably metamorphose at different sizes and cites as evidence "a cold, spring fed pond in Manchester, Maine, where metamorphosis was delayed as much as two or three weeks, yet none of the larvæ grew any larger before metamorphosis than those in warm, shallow pools either in Maine or Pennsylvania." He adds, "Laboratory conditions do not seem to influence size either, for the larvæ raised from the egg metamorphosed at about the same size; from 28 to 34 mm." As shown in the graph (Fig. 2), I collected a series of metamorphosing newts in the Mashpee ponds. They ranged from 46 to 75 mm. total length. Further, I metamorphosed in the laboratory as early as July 27 three newt larvæ, from the same locality, measuring 45, 49 and 50.5 mm. respectively in total length. On the other hand, metamorphosed adults from Mashpee may range as low as 38 mm. total length. There is no doubt from the graph that some Mashpee newts in nature normally reach over 70 mm. total length before beginning metamorphosis. In contrast to this I found that larvæ from Whittemore's Pond and Weeks' Pond metamorphosed usually at a much smaller size. Of 380 metamorphosed newts from Whittemore's Pond, collected during July and August, the smallest was 37.5 mm. total length when taken in the field, while I collected larvæ as large as 50 mm. total length from the same locality. It appears, from the above, impossible to judge the years which have elapsed since metamorphosis on the basis of size alone, although Pope (1928) does not hesitate in reaching conclusions with such data.

At Woods Hole I studied over a thousand newts, 880 of which have been used in the construction of the graphs. All of these newts were collected in the water whether they were larvæ, immature metamorphosed individuals, or adults. One would conclude from field observations alone that the newt of the Woods Hole region never left the water for any extended period. But Pope (1928) states: "Various observers, from Monks (1880) down, have agreed that the larva becomes terrestrial upon metamorphosis. After a certain stage the metamorphic newt becomes helpless in the water and sometimes drowns unless given a chance to crawl out on land." This statement, if true, would not affect the conclusions I reached in the study of the Long Island newts for while I found that they passed "one spring and summer as dark reddish or yellowish forms in the water before reaching sexual maturity," I also found that "many of the ponds inhabited by newts either dry up entirely or become very low in the fall" and recently metamorphosed newts would have a short, enforced stay on land before the spring rains flooded their pools. However, I have tested Pope's contention by experiments on both Whittemore and Mashpee newts:

On July 11, I placed three larvæ from Mashpee in a jar with approximately a liter of water but without water-weed or floats. By the 27th all had metamorphosed and none during the process had floated for any period near the surface or showed any other symptoms of drowning. On July 17, I placed three others which had already begun to metamorphose in another jar without floats. By the 27th these had also metamorphosed in the water, without difficulty.

On August 8, several larvæ collected at Weeks' Pond were placed in a glass aquarium with approximately the same amount of water and by the 23d one of these had metamorphosed without making any attempt to leave the water.

On August 26, twenty-one of the larvæ collected at Whittemore's Pond metamorphosed in the small wooden tubs of several liters capacity where they were being kept in the dark. Only two of these were seen to be paddling near the surface in the manner common to many metamorphosing salamanders. This exception to the above results may be accounted for by assuming an overcrowding in the tub.

On August 31, one larva from Weeks' Pond, and a series from Mashpee and Whittemore ponds metamorphosed without any deaths and yet none left the aquaria or were seen floating near the surface.

These observations show conclusively that newts collected in the Woods Hole region may successfully metamorphose in the water without any extensive floating period and without the assistance of floats.

The chief point of Pope's recent paper (1928) is the reiteration of his belief that the red, land stage is not omitted from the life-history of any individuals of *Triturus viridescens*, even of those on Long Island which I showed to have a post-metamorphic life in the water before reaching sexual maturity. This subject may therefore be considered in some detail. Pope states: "there is much negative evidence from Gage (1891) down to show that intermediate sizes are not to be found in the water." An examination of the size graphs of the 880 newts from the ponds of the Woods Hole area, collected during July and August, 1928, will show positive evidence that all the intermediate sizes occur in the water during these months. Further, except for newts which live in temporary ponds, there is some positive evidence that the greater part of the newt population never leaves the ponds at any time of the year. This evidence is the presence of gill-rudiments and frequently gill-slits and larval branchial apparatus in metamorphosed newts. Of 249 metamorphosed newts collected in the Mashpee ponds only 13 lack gills or gill-rudiments and no less than 96 have the gill-slits fully open. Many breeding adults of both sexes have the gills fully developed although usually one or more is missing, apparently due to their having been bitten off. Adult newts having rudimentary gill-stubs almost invariably have the opercular fold fused to the throat and the gill-slits more or less closed. Of 380 metamorphosed newts collected in Whittemore's Pond only 3 small individuals were found with the gill-slits fully open. The great majority had the gill-slits closed but retained rudimentary gills, while 45 lacked all evidence of gills. Thus the Mashpee newts not only tend to reach a larger size before metamorphosing as shown above, but they tend to retain gill-slits, opercular fold, and well-developed gills. Further, gills or gill-rudiments are present in 95 per cent as contrasted with 88 per cent in the Whittemore newts.

It would seem certain that all newts with open gill-slits never passed an extensive period on land, while it would appear probable that none with gill-rudiments had enjoyed a terrestrial stage. I have tested this proposition by a number of experiments.

On July 11, seven recently metamorphosed newts with prominent gill-rudiments collected in Mashpee ponds and averaging 54.5 mm. total length were placed in a glass jar with dirt and damp moss but no free water. Seven others were put in a jar of the same size and about a liter of water added. By August 8 all trace of gill-rudiments had been lost from the first series while none had been lost from the second.

On July 17, five recently metamorphosed newts from the same place and about the size of the above were placed in a jar of the same size half full of wet sphagnum. Three of these had gill-rudiments. By August 8 all had lost the gill-rudiments.

On August 23, four large adults ranging from 74.5 to 94 mm. total length and averaging 82 mm. were placed in a glass jar with dry dirt and a little water added. These newts had the gill-clefts wide open, the opercular fold free and distinct gill-rudiments present. A control series, eleven others, were kept in water. ByAugust 31 it was necessary to discontinue the experiment but at this time three of the four had the gill-clefts closed and the fourth, which retained the largest gill-rudiments, had the clefts partly fused. In all four the gill-rudiments had become reduced.

These experiments demonstrate that terrestrial life causes a reduction of the gill-stubs and a fusion of the gill-clefts in metamorphosed newts. As enforced aquatic life never caused the redevelopment of the gill-stubs in any of the newts, I conclude that none of the adults having open gill-clefts or prominent gill-rudiments ever passed through a terrestrial stage in their life-history.

Nevertheless, it is probable that some newts in the Woods Hole region may undergo terrestrial migrations in the fall. Weeks' Pond was rapidly drying up by the end of August and Whittemore's Pond was low. It is highly probable that newts would hibernate among the aquatic vegetation at the bottom of the latter pond but Weeks' Pond had little vegetation and if any water remained during the winter it would freeze to the bottom. Thus it would seem possible that newts, to survive, would leave Weeks' Pond in the fall to hibernate under logs in the adjacent wood. On August 8 I found seven newt larvæ in this little pond but not a single adult in spite of a thorough scooping. No fish occur in this pond. I can think of no reason for the absence of adults other than that they left the pond as the water became low. No newts were seen by me on land although parts of several days were spent in turning over logs near the various ponds.

It is, therefore, possible that a few newts in the Woods Hole region undergo terrestrial migrations, but the great majority pass their entire life-cycle in the water. This raises the question of what happens to the red-eft stage in the ontogeny of these newts. In this connection the following observations are of interest.

(a) A series of newts was collected at Mashpee, July 9. On the same day several of these shed their skins indicating the beginning of metamorphosis. One metamorphosing individual measures 56.3 mm. total length (27.5 head and body-length) while two larvæ measure 52 and 57 mm. respectively in total length (24.7 and 18.5 head and body-length). In the same series there are fully metamorphosed (except for branchial region) adults measuring only 39, 43, and 46.5 mm. total length and many others ranging to a maximum of 97.7 mm. total length. None of the recently metamorphosed newts are reddish but a few are yellower than the others. Metamorphosis is marked by a change in coloration. The small larva is uniformly greenish gray, faintly stippled with a dark tone except for the immediate vicinity of the lateral-line organs, which is generally unpigmented. A series of indistinct dark spots is scattered over the body and is best developed on the tail. Metamorphosis induces an increase in number and size of the larger dark spots, particularly those on the body. It causes the appearance of yellow spots which later become vermilion and affects a darkening and a marked increase in the opacity of the integument. The larger larvæ assume some of the coloration of metamorphosis, for the skin is much browner, more spotted, and more opaque than that of smaller larvæ. Recently metamorphosed newts vary from brownish or yellowish to greenish.

(b) In a series of newts collected at Mashpee, July 16, there is one metamorphosing individual 75 mm. total length (36 mm. head and body-length). The larvæ measure from 48 to 61 mm. total length (28.5 to 39.5 mm. head and body-length). Some of the recently metamorphosed individuals measuring 69 to 72.5 mm. total length are distinctly reddish but others of the same size are brownish to brownish green. There is no difference of color between the coloration of the latter and that of newts over 90 mm. in total length.

(c) The larvæ collected July 11 and metamorphosed July 27 in the laboratory remained brownish and did not take on a reddish or orange hue. Of those larvæ collected July 17 and metamorphosed July 27 three took on a decided orange tone and one remained brownish. The metamorphosed individuals were kept in a separate terrarium and by August 31 none showed any further change in their coloration.

(*d*) The recently metamorphosed newts reported above as being placed in a dry terrarium turned dark chocolate-brown and developed rough skins; those placed in wet moss turned dark brown, slightly tinged with greenish. The controls remained brownish green. Thus, forced land-life caused a darkening and a browning of the skin but it did not induce the appearance of a reddish color.

(*e*) On August 21, eleven larvæ ranging from 60 to 65.5 mm. total length were collected at Mashpee, besides seven metamorphosing individuals of 46 to 66.3 mm. total length (22.5 to 31 mm. head and body-length). Several of these showed a decided reddish tone while others were merely brownish. Larvæ collected the same date ranged as small as 27 mm. total length (14.5 mm. head and body-length).

On August 26, twenty-one larvæ from Whittemore's Pond were metamorphosed in the laboratory without one showing any reddish or orange tone. Six more metamorphosed the 29th and a large number not included in the graphs on the 30th. None of these showed any reddish tones.

(*f*) A series of 14 newts from Whittemore's Pond were metamorphosed in the laboratory and kept in a terrarium at the American Museum in good health until the time of writing this note (February 1). One well-fed individual has become reddish brown but none a vermilion such as the color of a typical red eft. A control series has been kept in tanks well supplied with water-weed; these are paler and greener than the terrarium series.

From the above data it is clear that the newts of the Woods Hole region, unlike the Long Island newts, usually lack a reddish or orange color-phase in their ontogeny. Some newts from the Mashpee ponds exhibited a distinct suggestion of this color-phase but the Whittemore newts which metamorphose at a smaller size usually gave no evidence of passing through a reddish phase. Thus it appears that a terrestrial stage and a bright reddish color-stage, which usually coincide in Appalachian newts, are both lacking in Woods Hole newts, although a suggestion of the latter may occur in a few newts before metamorphosis and be continued for some months thereafter.

It has been demonstrated above that there is no terrestrial stage in the life-history of the Woods Hole newt and the stage will very probably be found to be omitted from the life-cycle of other newts living on the coastal plain. I have never found a typical red eft, and by this I mean the vermilion terrestrial form, on Long Island nor have any of the various naturalists who live there brought me one alive. However, Dr. S. C. Bishop, Mr. G. Engelhardt, and Mr. W. J. Shoonmaker collected a reddish immature newt 57 mm. in total length, on October 16, 1925, on the Hudson Estate, Syosset, at a distance from water. This is the place where November 8, 1921, I caught brownish newts under logs near water and considered them to be hibernating (Noble, 1926, p. 11). I have compared the first-mentioned newt with an individual which I collected as a larva at Mashpee and kept for a month after metamorphosis in a dry terrarium. There is no significant difference in size, dorsal coloration, or rugosity of skin in these two specimens. The ventral tone is slightly yellower in the Long Island specimen but this, as has been pointed out previously (Noble, 1926, p. 6), is a characteristic of aquatic Long Island newts. The specimen which was considered by its discoverers to be a red eft is in all probability an immature reddish newt beginning its hibernation on land. At least this specimen can not be taken as evidence that the red-eft stage occurs on Long Island. Newts, as I previously stated, may winter on land or in the water but the immatures never become vermilion or remain on land more than the one winter.

NEOTENY AND THE PROBLEM OF METAMORPHOSIS

The above observations are of interest in their bearing on the problem of metamorphosis. I have reported above the first instance of true neoteny in *Triturus viridescens*. Newts collected from the same pond have their metamorphic processes so delayed that frequently they fail to complete the transformation of all their structures. True neoteny or sexual maturity in the larval individual has been reported for various European newts: *Triturus alpestris*, Wichand (1906), Zeller (1899); *T. tæniatus*, Zeller (1899); *T. cristatus*, Ebner (1877), Kuhn (1925); and *T. vulgaris*, Bœttger and Schwarz (1928). Wichand (1906) described a case in *T. vulgaris* similar to the large Mashpee newts where all the external characters of the adult were developed but the gills were retained. By far the greater number of European naturalists have not distinguished in their writings between complete and partial failure to metamorphose. This is unfortunate, for the two phenomena, while unquestionably genetically related, should be clearly distinguished.

True neoteny is well known in many urodeles other than newts. The most familiar example is the axolotl. Here we must distinguish between the various races. In the Mexican race raised extensively in Europe the neoteny is hereditary while in the western races of *A. tigrinum* neoteny is in some forms at least environmental, produced by the direct effect of the cold (Uhlenhuth, 1921). The latter would seem to be the cause of neoteny in some specimens of *Salamandra salamandra* (Germershausen, 1910), and possibly the cause of neoteny in *Dicamptodon ensatus*, although I know of no experiments which definitely establish the point. It is apparently also the cause of neoteny in *Hynobiuslich enatus* (Sasaki, 1924), for this species, when reared in small temporary pools, metamorphoses the first year, when in cold lakes it reproduces as a larva. Cold would also seem to be the factor preventing metamorphosis in various newts living at high altitudes, as for example, in *Triturus alpestris* (Wichand, 1906). The mountain species, *Triturus wolterstorffi*, to judge from Boulenger's (1905) account, undergoes a partial metamorphosis similar to some Mashpee newts. On the other hand it has been well established that neoteny may occur sporadically among newts and other salamandrids living in warmer waters at low altitudes. The case reported by Van Swinderen (1924) in *Triturus tæniatus* was apparently very similar to that of the Mashpee newts, for the greater number of adults collected from a particular bog were neotenic. Van Swinderen describes them with gills present and with gill-slits open but does not state if the remainder of the characters were similar to those of a metamorphosed individual. Van Swinderen bred a neotenic female with a metamorphosed male and obtained 30 young, half of which were neotenic. The experiment, although incomplete, further suggests that newts localized in particular ponds may not metamorphose because of certain genetic factors. Van Swinderen makes it clear that his neotenic newts were maintained in good health.

If metamorphosis in some races of axolotl and in some localized groups of Old World newts is prevented by a hereditary cause, what might be the nature of this factor? It is well known that metamorphosis is induced by the secretion of the thyroid gland. Kuhn (1925) claimed that the thyroid of a neotenous *Triturus cristatus* showed various abnormal features but Duchosal and Junet (1927) failed to find any significant differences between the thyroid of a neotenous *T. alpestris* and that of a metamorphosed individual. Both observers may be correct, for in one case neoteny may be due to an abnormality of the thyroid and in another to the fact that an environmental or a genetic factor has prevented the release of the colloid from the thyroid follicles. Both Uhlenhuth (1921) and Swingle (1922) have stressed this releasing factor in their writings. Experiments in recent years have emphasized the close functional relationship between the anterior lobe of the pituitary and the thyroid. Hereditary neoteny may be due to changes in the thyroid or in mechanisms controlling the function of the thyroid. In the case of the Mashpee newts no attempt has been made at this time to determine whether the effect is environmental or genetic. But if the latter should prove to be the correct explanation it would lend support to the suggestion that the loss of the red-eft stage was also due to genetic factors.

There is another aspect of the problem of metamorphosis on which the present study has a direct bearing. I have indicated that authors have frequently failed to indicate whether they were considering sexually

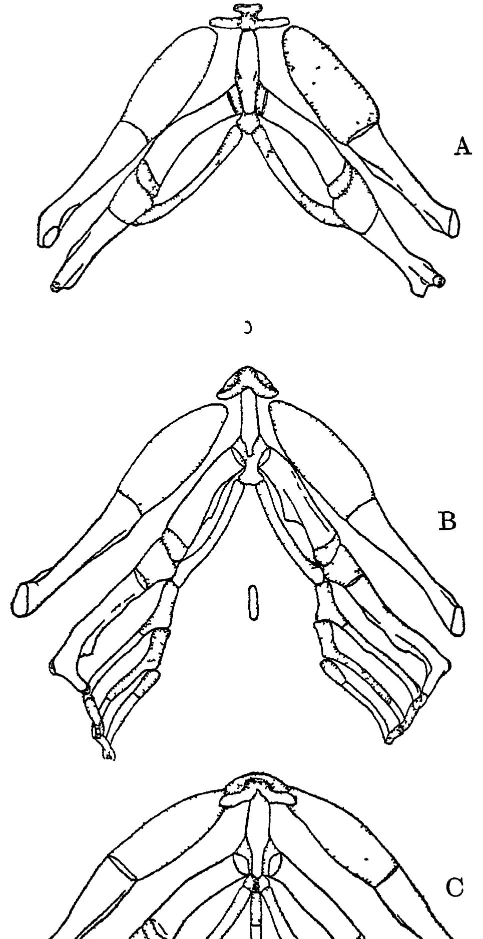


Fig. 5. Variation of hyobranchial apparatus of three adult male newts collected at Mashpee ponds, August 21, 1928. ×10.

(*a*) The gill-clefts closed and the gills reduced to stubs.
(*b*) The gill-clefts open but the opercular fold partly fused. Gill-rudiments present.
(*c*) Gill-clefts open and opercular fold free. Gill rudiments present.

Bone in outline, cartilage stippled.

mature larvæ or partly metamorphosed individuals. This raises the question: Does the delayed metamorphosis of the Mashpee newts shed any light on the nature of neoteny in the perennibranchs? An examination of the branchial apparatus of a series of adult male newts collected the same day in a Mashpee pond has revealed a great variation in the extent of transformation of this apparatus (Fig. 5*a*–*c*). Further, there is a close correlation with the extent of fusion of the opercular fold and closure of the gill-slits with the degree of metamorphic change attained by the branchial apparatus. On the other hand the degree of transformation has no relation to the extent of ossification of the hyobranchial apparatus. Thus, I find the hyobranchial apparatus in a series of recently metamorphosed newts from Whittemore's Pond is entirely cartilaginous while in the adults with gill-slits open, collected at Mashpee, some ossification occurs in each of the four pairs of epibranchials, as well as in other parts of the apparatus.

It is noteworthy that in practically all of the large adult male newts from Mashpee the skull has completed its metamorphic changes. The only exception I have found in a series of ten skulls is that one retained the coronoids in the lower jaw (Fig. 6) although these were fused to the dentaries. Thus the Mashpee newts eventually metamorphose completely except that some retain gills and open gill-slits. In those with slits open and opercular fold free the branchial apparatus of the larva is retained while those which have undergone some fusion in fold exhibit some metamorphic change in the hyobranchial apparatus. Has the fact that the hyobranchial apparatus is the last part of the skeleton to undergo metamorphosis any general significance?

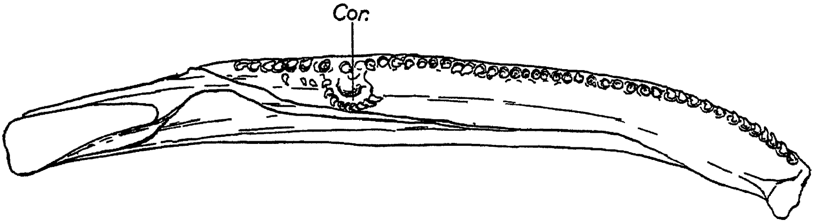


Fig. 6. Oblique view from above of the left half of the lower jaw of an adult female newt showing the retention of the coronoid. The gill-clefts were closed in this individual. ×20.

Cor =Coronoid.

There is considerable difference of opinion in the literature as to the extent of metamorphic change which the various perennibranchs exhibit, and it may be of interest to see what bearing the delayed metamorphosis of the Mashpee newts has on this subject. If we consider only the most obvious changes of ontogeny, namely, the development of limbs, of maxillary bones, the loss of gills and reduction of branchial apparatus, etc., we might consider *Siren* a form which has ceased to differentiate beyond a very early stage of larval life. *Proteus* and *Necturus* would be forms which had reached a later stage of urodele ontogeny, *Cryptobranchus* one which had begun its metamorphosis, and *Megalobatrachus* and *Amphiuma* forms which, like some Mashpee newts, had nearly completed their metamorphosis.

A closer examination of the development of the perennibranchs will reveal that none of them run through a series of developmental stages identical in detail with those of caducibranchs. In all cases the growth or differentiation of certain parts is either speeded up or else eliminated entirely, making it difficult to compare the various stages in forms which are permanent larvæ with those which metamorphose. This state of affairs may be considered more closely.

The morphology of metamorphosis in urodeles has been considered recently in great detail by Wilder (1925) who states: "H. H. Wilder (1891) showed the similarity of *Siren* to *Siredon* (axolotl) and designated *Siren* as a degenerate larval form. With the more extended recognition of stages of development involved in the present discussion, I should classify *Siren* as a degenerate late metamorphic or transition form. The recently reported case of an example of *Siren* in which gills were wanting (Viosca, 1924) is corroborative of this view."

The loss of the gills has nothing to do with metamorphosis in *Siren* as I showed by experiment (Noble, 1924) but may be readily induced by keeping the animals in irritating fluids. Further, Blatchley (1899) had previously found *Siren* on land with the gills fully reduced. Irritating media or exposure to air induce a reduction of the gills but do not affect the branchial skeleton or other parts of the animal's organization.

On the other hand, *Siren* is distinctly a larva in its jaws (maxillaries lacking, dentigerous coronoids, and horny dentary plates present), its lidless eyes without lacrymal ducts, its hyobranchial apparatus, its hæmal arches incomplete ventrally, and its limbs—the hind pair never developing. Further, its glandless cloaca might be considered a larval feature. What, then, are its late metamorphic characters which Wilder stresses? Wilder does not state, but by comparison with the earlier literature and with the long list of criteria of metamorphosis given for *Eurycea bislineata* we may conclude that there are a number of modifications in *Siren* which require further explanation.

EAR OSSICLES.—Reed (1920) states that "the complete absence of the columella in *Siren* points to an extended period of terrestrial existence further back in its phylogeny." It is probable that the most primitive urodeles were largely terrestrial, but has this any bearing on the loss of the columella of *Siren?* I have found from the study of a series of cleared specimens of *Siren* that the operculum begins to ossify when the animal is only 55 mm. in total length. At this time the squamosal is approximately seven times the greatest length of the operculum away from the latter structure. In *Necturus* and *Typhlotriton* larvæ of about the same stage the distance between squamosal and operculum is approximately equal to the length of the latter. It would seem that the lengthening and narrowing of the snout in *Siren* had carried forward the squamosal, and the columella never formed, since it could not function without enormously increasing its length. I have not seen any change suggestive of metamorphosis in the otic apparatus of *Siren.*

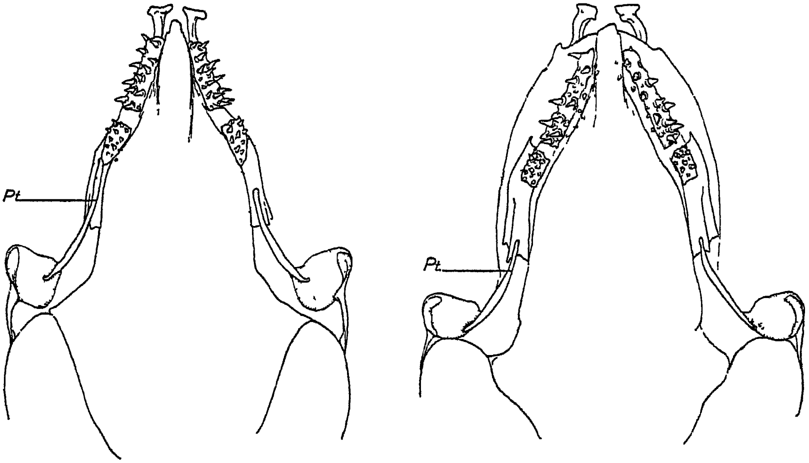


Fig. 7. The splitting of the palato-quadrate bar in *Siren lacertina,* a change which resembles metamorphosis in part but which is probably due to the disharmonic growth of the head. Ventral aspect of the palate region. × 30

(a) Individual, 42 mm. total length, showing the break on the left but not on the right side.
(b) Individual, 51 mm. total length, the pterygoid elements having already begun to degenerate.
***Pt* =Pterygoid.**

PTERYGOID.—One of the most conspicuous changes of metamorphosis in urodeles is the splitting of the pterygo-palatine bar into two main parts. (Compare Wilder, 1925, Plate VIII, fig. 6, and Wintrebert, 1922, Fig. 37, with my Fig. 7.) Subsequently the bony pterygoid may be lost or considerably altered in form. A similar phenomena occurs in *Siren* between the 55 and 60 mm. stage. And subsequently the bony remnant of the pterygoid is lost as a distinct element. But the palatine element of the bar fails to continue the usual changes seen during metamorphosis in other salamanders.

Hence, here again we may consider this change as due to disproportionate growth of adjacent areas rather than to a thyroid activity. No metamorphic change of eyes, gills, branchial arches, or any other part of the animal occurs at this time, which is further evidence that the change is not to be considered one of metamorphosis.

JACOBSON'S ORGAN.—Another peculiarity of the adult *Siren* which might suggest that the species was well on the road to metamorphosis is its extraordinarily developed Jacobson's Organ. Wilder (1891) compared the Jacobson's Organ in *Siren* with that in the axolotl. As it is well developed in the latter the presence of a Jacobson's Organ is no criterion of metamorphosis. What might its hypertrophy signify? *Siren*, in spite of its long body, is not a burrowing but an aquatic form. Bruner (1914) pointed out that the external nares of *Siren* were valveless and this alone would preclude extensive burrowing operations. Gothard (as quoted by Werner, 1912) has shown in the laboratory that the species is primarily aquatic. But Blatchley (1899) and Viosca (1924) have noted in the field that the animal may live on land. The Jacobson's Organ is generally believed to have developed in the first tetrapods in correlation with land-life and it is possible that its hypertrophy in *Siren* may have developed in connection with special feeding habits in or out of water. As Jacobson's Organ develops before metamorphosis in many salamanders its presence in *Siren* is of interest but has no bearing on the present problem.

SKIN.—Endocrinologists who have studied the metamorphosis of Amphibia usually consider the first shedding of the skin in large pieces as proof that metamorphosis has begun. As pointed out many times, this shedding is usually accompanied by definite changes in the structure of the epidermis. The most conspicuous change in urodeles is a loss of the large Leydig cells. Other changes include the cornification of the superficial layers of the epidermis, the increase in thickness of the epidermis, the increase in the number of glands, etc. The changes in the epidermis differ with the species but most investigators have settled on the shedding of the skin as one of the most convenient criteria of metamorphosis and the loss of the Leydig cells has been considered proof that metamorphosis has occurred (Opacki, 1926).

Turning to the perennibranchs and derotremes we find that these criteria would define several forms as having metamorphosed. Wilder (1925) states that *Cryptobranchus*, *Amphiuma* and *Siren* "have a characteristically adult type of glandular skin with a remarkably well-developed *stratum corneum*, and with no Leydig cells, while in other respects the first two at least exhibit a fully adult, though somewhat degenerate structure. *Siren* alone with its retention of larval gills suggests the possibility of a form which has reached the late metamorphic stage with failure to transform and has secondarily become degenerate in structure."

As I have not made a histological study of the skin of perennibranchs or derotremes at different stages, I am unable to state when this apparent metamorphosis of the skin occurs. At the present moment the skin alone, of all the structures of *Siren*, seems to have undergone a complete metamorphosis.

Wilder (*loc. cit.*) speaks of *Cryptobranchus* and *Amphiuma* as exhibiting a "fully adult" structure. This would not apply to the branchial arches which are more larval than adult. Nor would it apply to the eye region. The lack of lids and lacrymal duct is a larval feature although Plate (1924, p. 309) attempts to correlate these losses with a degeneration of the eyes instead of with the more obvious feature of failure to metamorphose. The anterior position of the vomerine teeth is a larval character especially in *Cryptobranchus.*

The loss of gills in *Cryptobranchus* at a certain stage of development has been considered evidence of metamorphosis and the fusion of the opercular folds to the underlying integument would certainly come under this head. *Megalobatrachus* undergoes a partial metamorphosis of its branchial apparatus (Fukuda, 1928). If every perennibranch began as *Megalobatrachus*, with a typical larval hyobranchial apparatus, we could state to what extent each species is metamorphosed, for we could utilize as a scale of reference the degree of change in this apparatus. I have examined young *Amphiuma* within the egg-capsule, as well as older individuals, and have found that the second ceratobranchial is lacking in all. In *Necturus*, shortly after hatching, I have found the branchial arches to have the same reduced number and general form as the adult. It seemed in both these cases as if not enough branchial arch-forming material had been present when the arches were laid down, for certainly these reductions were in no sense a metamorphosis. Again, the development of the maxillæ in *Eurycea bislineata* is considered one of the criteria of metamorphosis by Wilder (1925), but these structures are present in old axolotls which no endocrinologist has ever considered to be metamorphosed. Further, in *Amphiuma* the development of the maxillæ is not correlated with any definite metamorphic change. In brief, metamorphosis is a series of changes proceeding at different rates and at different times in different species. For purposes of description it is necessary to consider one or more characters as the more important criteria. As *Megalobatrachus* undergoes more metamorphic changes than any other perennibranch or derotreme it may well be considered the standard of reference. In this species the changes in the hyobranchial apparatus seem to mark the climax of metamorphosis. We may describe *Megalobatrachus* as an enormous hynobiid salamander which has well begun but not quite completed its metamorphosis. Referring the Mashpee newts to the same standard it is found that they have run ahead of *Megalobatrachus* in the eye, lacrymal, and vomerine changes while many have fallen behind in the branchial changes. Comparing *Siren* to the standard it would be classified as a little developed larva which has hypertrophied its Jacobson's Organ and reduced its pterygoid while developing certain peculiarities such as the ossified coracoids, elongate body, and reduced ear ossicles. It may have evolved from hynobiids but the relationship is not close.

The Mashpee newts are of interest for they show how variable one of the best criteria of metamorphosis, namely, the degree of change in the hyobranchial skeleton, may be in some cases. Further, they show to what a great extent apparent metamorphic changes in the branchial region may be affected by the environment.

CONCLUSIONS

(1) The newt of the Woods Hole region passes through no terrestrial red-eft stage but usually lives throughout life in the water. Since temporary pools may be inhabited by newts some migration may occur. During July and August all growth-stages above that of the early larva are found in the water.

(2) Some male newts reach sexual maturity one year after metamorphosis.

(3) A typical larva from a Mashpee pond was found to contain fully formed spermatozoa. This is the first report of true neoteny in *Triturus viridescens.*

(4) Many newts in the Woods Hole region fail to complete metamorphosis but retain open gill-clefts, a more or less larval branchial apparatus and gills partly or fully developed. Partial neoteny is more pronounced in the Mashpee than in other ponds.

(5) The subjection of the incompletely metamorphosed newts to terrestrial conditions causes a fusion of the gill-clefts and a reduction of the gill-stubs.

(6) Perennibranchs and derotremes are not urodeles which have ceased differentiation at definite ontogenetic levels. Some of their structures, such as the skin, may have metamorphosed while others, such as the jaws, may have remained those of a larva. Certain larval structures may never appear during ontogeny, while others undergo changes which are not metamorphic.

(7) *Siren* is a form which has ceased to differentiate most of its structures beyond the stage characteristic of an early larva.

(8) Metamorphosis is a series of changes proceeding at different rates and at different times in different species.

(9) The degree of change in the hyobranchial skeleton affords one of the best criteria of metamorphosis.

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AMERICAN MUSEUM NOVITATES

Number 349
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
April 29, 1929

59.57, 96 (9)

THREE NEW GENERA OF ANTS FROM THE DUTCH EAST INDIES[1]

BY WILLIAM MORTON WHEELER

AMAUROMYRMEX, new genus

WORKER.—Monomorphic, slender. Head moderately large; eyes very small, situated at the sides and slightly in front of its middle; ocelli absent. Mandibles subtriangular, dentate. Clypeus short and broad, extending back between the frontal carinæ, its anterior border without teeth or carinæ. Frontal carinæ well-developed but short, slightly closer together than their distance from the lateral borders of the head. Frontal groove absent; frontal area rather large but indistinct. Antennæ slender, 11-jointed, funiculus with club consisting of two nearly equal joints; first funicular joint more than twice as long as broad, joints 2–8 small, subequal. Thorax slender; pro- and epinotum each with a pair of spines; promesonotal and mesoëpinotal sutures obsolete; mesoëpinotal constriction distinct. Petiole slender, with well-developed node, its lower surface unarmed; postpetiole evenly convex above. Gaster small; the first segment forming nearly three-fourths of its surface. Sting vestigial. Legs long, femora thickened apically; spurs of the posterior tibiæ delicate, scarcely thicker than the hairs, non-pectinate. Claws simple. Integument thick, sculptured, sparsely hairy.

GENOTYPE.—*Amauromyrmex speculifrons*, new species.

Amauromyrmex speculifrons, new species

Figure 1

WORKER.—Length, 2.5–3.5 mm.

Head slightly longer than broad, as broad in front as behind, with evenly convex lateral borders and concave posterior border; occipital border marginate; vertex and gula in profile flattened, especially behind. Eyes consisting of less than a dozen unequal facets. Clypeus somewhat flattened in the middle, the anterior border with a small, indistinct median emargination. Mandibles with convex external borders, 6-toothed, the two apical teeth and the basal tooth large, the three remaining teeth very small, separated by a diastema from the second tooth and diminishing in size towards the base. Antennæ slender; scapes straight, slightly enlarged towards their tips, which extend somewhat beyond the posterior corners of the head; first funicular joint about three times as long as broad; joints 2–8 distinctly longer than broad; club somewhat shorter than the remainder of the funiculus, its two joints rather slender, the basal narrower than the apical and about three-fourths as long. Thorax slender, decidedly narrower than the head, broadest through the pronotum; the meso- and epinotum narrow; pronotum slightly longer than broad, evenly elliptical from above, its dorsal surface depressed and moderately flattened, very feebly convex in profile; the pair of spines rather blunt, somewhat longer than broad at their bases, flattened and projecting outward and slightly forward and upward. From the base of each spine backward, the sides of the pronotum are distinctly marginate. The mesonotum seen from above is rectangular and parallel-sided, longer than broad; it gradually slopes downward and backward to the mesoëpinotal constriction. Epinotum broader than the mesonotum, somewhat broader than long; its base moderatly convex in profile, longer than the declivity, which is vertical, marginate on the sides and rather concave medially; the spines are as long as their distance apart at the base, slender and acute, directed upward and outward and with their tips curved forward. Petiole very slender, nearly three times as long as broad, gradually broadened behind where it bears a rounded-conical node, through which the petiole is as high as the length of the peduncle; ventral surface evenly convex and finely crenulate in profile. Postpetiole fully half again as broad as the petiole, nearly one and one-half times as long as broad, subelliptical in profile, evenly convex above but decidedly lower than the petiolar node. Gaster smaller than the head, elongate elliptical, narrowed anteriorly. Distal halves of femora decidedly thickened, their bases and the tibiæ slender.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 309.

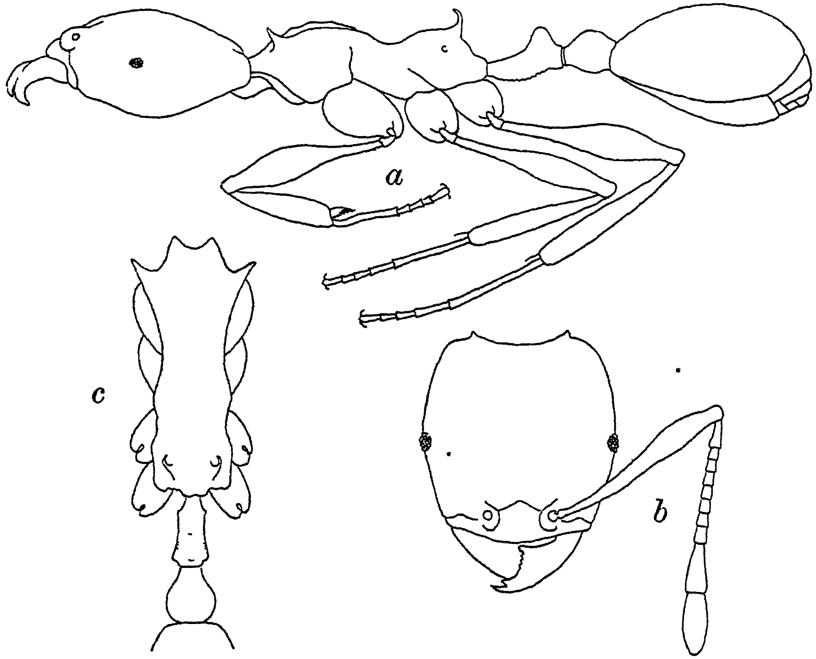

Fig. 1. *Amauromyrmex speculifrons*, new genus and species.
a, worker in profile; b, head of same, dorsal view; c, thorax and pedicel, dorsal view.

Feebly shining; mandibles subopaque, sharply and densely striate; front of head over a squarish area bounded anteriorly by the frontal carinæ and as far back as the posterior fourth, very smooth and shining; remainder of head, thorax and petiole sharply and regularly reticulate-rugulose, the gula anteriorly and the cheeks with longitudinal rugæ. The latter spread out fan-wise around the antennal foveæ. There are rugæ also on the thoracic dorsum but they are irregular, loose and vermiculate; sides of epinotum with several longitudinal rugæ. Petiole more finely reticulate than the thorax. Postpetiole, gaster and legs shining but with rather uneven surface and with sparse piligerous punctures. Scapes and coxæ indistinctly shagreened, less shining than the legs.

Hairs yellowish, coarse, sparse, pointed, of very uneven length; long and erect on the dorsal surface, especially on the pronotum, clypeus and gaster; shorter and oblique on the legs and scapes.

Mandibles, head, thorax and coxæ deep reddish brown; petiole, postpetiole, gaster, legs and antennæ paler and more yellowish brown; first gastric segment, except anteriorly, dark brown.

Described from seven specimens taken by Dr. E. Mjöberg on Mt. Poi, at an altitude of 8000 ft., Sarawak, Borneo (type-locality), and eight specimens, taken by Dr. K. Dammerman at Doerian in the Riouw Archipelago, near Singapore. Four of the latter series are defective.

The genus *Amauromyrmex* is obviously related to *Pheidologeton* Mayr, but there is nothing to indicate that the worker is represented by any large media or soldier form in addition to the form above described. Moreover, no species of *Pheidologeton* is known to have spines on the pronotum. The affinities of the new genus to the two known species of *Erebomyrma* Wheeler from Texas and Peru, and especially to *Spelæomyrmex urichi* Wheeler from Trinidad, seem to be much closer, but *Spelæomyrmex* has the clypeus toothed and carinate, the basal joint of the antennal club only one-third as long as the terminal joint, the pronotum merely angulate at the humeri and the posterior tibiæ without spurs. In most other respects the resemblance is striking. *Amauromyrmex* also resembles *Lophomyrmex* Emery, especially in the structure of the pronotum, but the latter genus has a 3-jointed antennal club and distinct promesonotal and mesoëpinotal sutures. The small eyes and long, sparse, erect hairs seem to indicate that *Amauromyrmex* is hypogæic in habits like *Erebomyrma* and *Spelæomyrmex*.

BREGMATOMYRMA, new genus

FEMALE.—Robust, with thick, smooth integument. Head very high and convex in the middle, depressed at the posterior corners, which are rounded; the occiput deeply excised in the middle. Eyes very prominent but rather small, situated at the sides of the head and just in front of its middle. Ocelli large and prominent. Palpi very small and short. Mandibles well-developed, subtriangular, dentate, narrow at the bases which are inserted rather far apart near the anterior corners of the head. Clypeus broad and short with nearly straight anterior border; its posterior border straight and not continued back between the frontal carinæ. The latter very short and neither prominent nor covering the antennal insertions, sigmoidal, moderately far apart. Antennæ 12-jointed, long, inserted very close to the clypeus; scape stout, funiculus very slender, not thickened towards the tip; first joint shorter than the second. Antennal and clypeal foveæ not confluent, the latter indistinct. Thorax robust and massive, broader than the head; mesonotum very prominent anteriorly, epinotum smooth and unarmed, its spiracles circular. Petiole large, with a very thick, rounded node above. Gaster short and subglobose, not longer than broad, very convex above; first segment short, not longer than the second and third together. Legs very long; femora, tibiæ and metatarsi flattened; spurs of posterior tibiæ very small and short. Claws simple. Wings lacking.

GENOTYPE.—*Bregmatomyrma carnosa*, new species.

Bregmatomyrma carnosa, new species

Figure 2

FEMALE (deälated).—Length, 7 mm.

Head distinctly broader than long; very slightly narrower in front than behind, with straight sides; the posterior border broadly, deeply and arcuately excised, the posterior corners rounded and lobular, but thick; the front and ocellar region very high and convex, the surface falling abruptly and almost perpendicularly behind the posterior ocelli to the occipital foramen and less abruptly and concavely to each posterior lobe. The prominent eyes are nearly circular, distinctly shorter than their distance from the anterior corners of the head. Mandibles long and rather narrow with feebly concave external borders and subequal basal and apical borders, the latter oblique and 5-toothed, their terminal tooth long and curved, the others subequal and rather broad. The mandibles overlap but leave a space between their inner angles and the clypeus. Clypeus not reaching to the corners of the head, nearly twice as broad as long, somewhat convex in the middle, its anterior border entire and feebly rounded. Frontal area small and indistinct, triangular; frontal groove represented by a distinct, narrow ridge extending back to the anterior ocellus. Frontal carinæ strongly diverging posteriorly. Antennal scapes curved only at the extreme base, otherwise straight, slightly dilated and flattened, extending about one-fourth their length beyond the posterior corners of the head; first funicular joint three times as long as broad; the remaining joints, except the last, gradually decreasing in length and all of the same thickness, the last joint somewhat more slender and as long as the two penultimate joints together. Thorax broader than the head, the mesonotum, scutellum and epinotum all broader than long; the pro- and mesonotum together as broad as long and nearly equalling the greatest height of the thorax. Mesonotum anteriorly continuing the vertical outline of the pronotum, the posterior surface very feebly ridged in the middle, its outline in profile nearly straight and horizontal. Behind the mesonotum the outline of the scutellum and epinotum form a gently sloping curve, the epinotum being evenly convex, without a distinct base and declivity. Petiolar node half as broad as the epinotum and less than one and one-half times as broad as long; from above broadly elliptical. In profile the petiole is somewhat higher than long, its ventral surface with a median convexity, its node thick and erect, with subequal, convex anterior and posterior surfaces and bluntly rounded apex.

Gaster broader than the thorax but shorter, its anterior border straight and transverse, rather sharply angulate on each side. Circumanal cilia long and bristly. Legs long, the femora, tibiæ and metatarsi distinctly flattened, the anterior femora not enlarged.

Mandibles, scapes, legs, gaster and petiole, except the anterior surface of the node, smooth and shining; mandibles coarsely punctate and along the dental border finely striolate. Head, thorax, coxæ and anterior surface of petiolar node subopaque, very finely reticulate punctate.

Hairs yellowish, fine and short, absent on the body, except the clypeus, suberect and moderately numerous on the legs and mandibles, sparse on the anterior surface of the scapes. Head, thorax, coxæ and anterior surface of the petiolar node covered with dense, fine, appressed, golden pubescence, which does not completely conceal the underlying integument though it produces a silky lustre. Antennal funiculi with longer, less appressed pubescence.

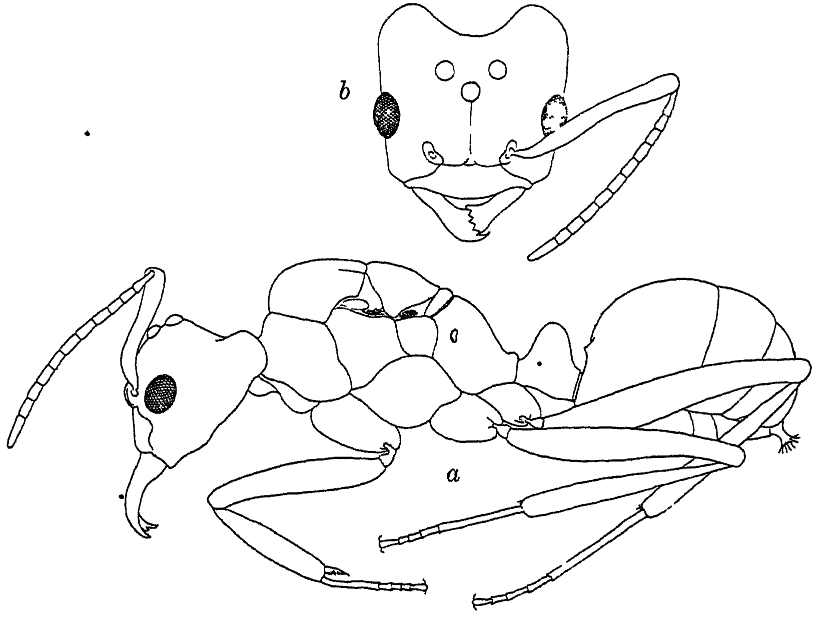

Fig. 2. *Bregmatomyrma carnosa*, new genus and species.
a, female (dealated), in profile; b, head of same, dorsal view.

Deep blood-red; the head, thorax, coxæ and anterior surface of the petiolar node darker and more blackish, but the sutures, wing-insertions and upper portions of the mesopleuræ paler and more ferruginous.

Described from a single specimen taken by Dr. E. Mjöberg at Pajan, in Dutch East Borneo.

This extraordinary ant is evidently to be regarded as the representative of a new tribe of Formicinæ, which may be called the **Bregmatomyr-**

minii, but the precise position of this group among the known tribes of the subfamily cannot be determined till the worker and male have been secured and the gizzard examined. The general habitus of the insect somewhat resembles that of *Pseudolasius* and suggests that it might be placed, for the present, near the tribe Lasiini.

MYRMAPATETES, new genus

MALE.—Head rather large and broad, with very large eyes, which take up nearly the whole of its sides; ocelli large and prominent; cheeks extremely short; face narrowed upward; clypeus extending backward in a blunt point between the antennal insertions, which are close together. Frontal carinæ undeveloped. Palpi very slender and delicate; the maxillary pair apparently 6-jointed, the labial pair 4-jointed. Mandibles very small, vestigial, drawn out at the tip into a long slender point. Antennæ 13-jointed, very slender and filiform; scape much shorter than the second funicular joint; first funicular joint small, not swollen. Thorax decidedly narrower than the head; pronotum well-developed, not overarched by the mesonotum, the latter with deep Mayrian furrows. Petiole with large erect node. Gaster short, with rather voluminous, exserted genitalia; last tergite somewhat beak-shaped, pointed. Cerci present. Legs slender; all the tibiæ with well-developed spurs. Claws simple. Wings with two cubital cells, a rather small discoidal and a closed submarginal cell.

GENOTYPE.—*Myrmapatetes filicornis*, new species.

Myrmapatetes filicornis, new species

Figure 3

MALE.—Length, 4.8 mm.; fore wing, 4.3 mm.

Head transversely elliptical, nearly one and one-third times as broad as long, with concave occipital surface and resembling the head of a dipteron. Antennæ inserted a little below the middle of the face. Clypeus as long as broad, subtriangular, moderately convex in the middle, with nearly straight anterior border. Frontal groove distinct anteriorly, posteriorly continued back as a rather deep impression to the anterior ocellus. Antennal scapes about two and one-half times as long as broad, cylindrical, broader than the funiculi; first joint of the latter a little longer than broad; joints 2–9 slender and elongate, gradually diminishing in length distally; joints 10 and 11 subequal, together as long as the preceding and terminal joint. Thorax about twice as long as broad, broadest through the mesonotum; pronotum transversely swollen; mesonotum and scutellum convex; epinotum evenly rounded and sloping, without distinct base and declivity. Petiole higher than long, the node thick, higher than broad, broader above than below, cuneate in profile, with subequal, flat anterior and posterior surfaces and blunt apex. Gaster elliptical, the first segment high and subtruncate anteriorly; external genital valves subquadrate, with broad excised apical border.

Head subopaque, very finely punctate-reticulate; thorax, petiole and gaster more shining, superficially and very finely punctate. Mayrian furrows on the mesonotum transversely rugose.

Hairs yellowish, short, rather few and scattered on the thorax, more numerous on the border of the petiolar node and on the gaster, especially on the venter. Whole body and appendages covered with very fine, appressed whitish pubescence, not very conspicuous or sufficiently dense to hide the underlying integument.

Brownish black, mandibles, mouthparts, tarsi and articulations of legs dull brownish yellow. Wings uniformly tinged with brown, with brown stigma and veins.

Described from a single specimen taken during December, 1907, by Dr F. Muir, on the Island of Larat, near New Guinea.

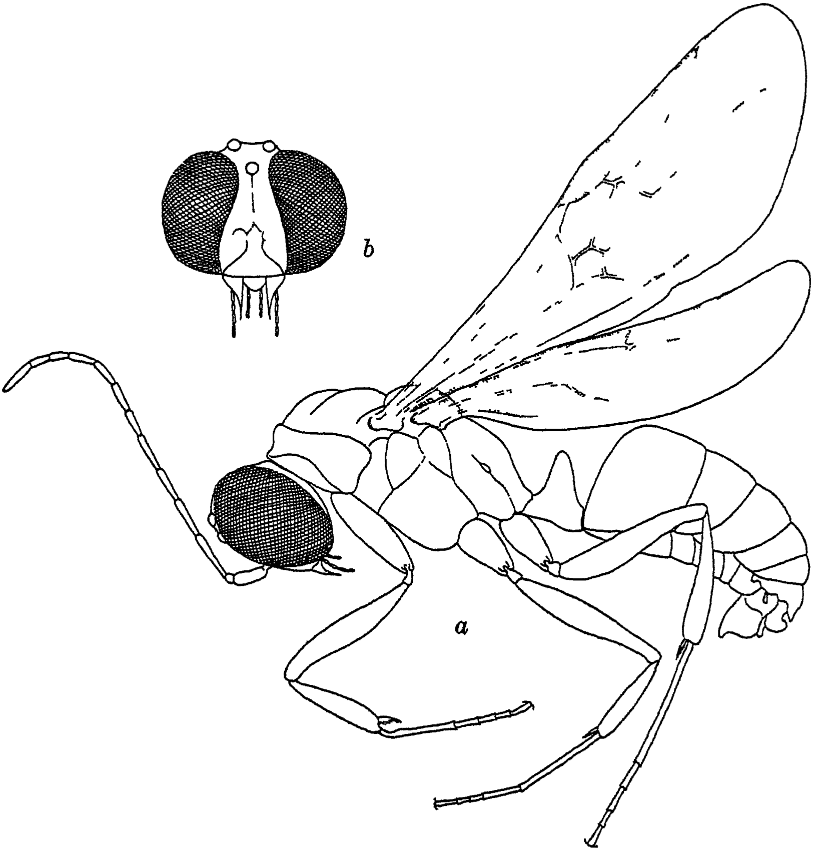

Fig. 3 *Myrmapatetes filicornis*, new genus and species.
a, male, in profile, *b*, head of same, from front

I have hesitated to describe this singular ant, which has been in my collection for many years, because its affinities seemed to be so obscure. It is obviously one of the Dolichoderinæ and resembles the male of *Dolichoderus* in wing-venation and the structure of the gaster and genitalia, but in no dolichoderine genus known to me does the male have Mayrian furrows on the mesonotum, or such peculiarly reduced mandibles, slender palpi and antennæ. The male of the primitive genus *Aneuretus,* however, is still unknown, and it is therefore possible that the specimen from Larat may belong to this or to some allied genus of which the worker has not been seen.

AMERICAN MUSEUM NOVITATES

Number 350 Published by The American Museum of Natural History New York City May 7, 1929

59.82 (96)

BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. VI[1]

By Robert Cushman Murphy and Gregory M. Mathews

Sylviidæ

Conopoderas æquinoctialis æquinoctialis (Latham)

Sylvia æquinoctialis Latham, 1790, 'Index Ornith.,' II, p. 553 (Christmas Island, Pacific Ocean).

Tatare æquinoctialis Sharpe, 1883, 'Cat. Birds Brit. Mus.,' VII, p. 528.

Adults (sexes alike).—Dorsal surface, olivaceous gray, approaching neutral gray on the scapulars and sides of neck, many of the feathers with whitish margins, narrow on the back, but broader on the rump and upper tail-coverts; in some specimens the latter areas are prevailingly pale buffy, perhaps as a result of wear and fading; wing quills, clove brown, the remiges tipped and externally edged with whitish, most broadly on the secondaries and tertials; more or less albinistic wing quills not unusual; under surface of remiges, mouse gray; lining of wing, whitish; coverts, like quills, but still more broadly tipped with grayish white; rectrices, clove brown dorsally, mouse gray ventrally, narrowly edged and more broadly tipped with whitish, in ventral aspect the whitish terminations being more extensive, showing in some specimens as conspicuous light spots on the inner vanes of the quills; an ill-defined whitish supraorbital stripe, which extends forward through the lores to the nostrils; cheeks, olivaceous gray; entire ventral surface, whitish, faintly tinged on flanks, sides of breast and belly with pale neutral gray, and on center of breast and belly with pale yellowish. Iris, brown ; bill, blackish on maxilla, horny or flesh color on mandible; lining of mouth, orange; legs and feet, "slaty."

Neotype.—No. 190,543, Amer. Mus. Nat. Hist.; ♂ ad.; Christmas Island, Line Group, Pacific Ocean; February 12, 1921; R. H. Beck.

Measurements.—(11 males): wing, 70–76 (73.4); tail, 57–64 (61.2); exposed culmen, 15–16.6 (15.8); bill from nostril, 10.8–11.2 (11); tarsus, 23–24.8 (24); middle toe with claw, 17 mm.

6 females: wing, 70–72 (71.3); tail, 57–61 (58.4); exposed culmen, 15–15.8 (15.3); bill from nostril, 11–11.2 (11); tarsus, 23–24 (23.5); middle toe with claw, 20 mm.

Range.—Christmas Island, Line Group.

Specimens from Christmas Island collected February 10–20, 1921.

Although this warbler was named one hundred and forty years ago and has since been collected on two or more occasions, no specimen appears to have found its way into a natural history museum previous to the series obtained by Messrs. Beck and Quayle of the Whitney Expedition. The species proves to be of rather unexpected appearance, being of a gray and white cast and equally different from the yellow representatives of *Conopoderas* of the Marquesas and Society Groups on the one hand, and the brownish races of the Tuamotus on the other.

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[1] Previous papers in this series comprise American Museum Novitates, Nos. 115, 124, 149, 322, and 337.

Most of the nineteen specimens were preparing to breed, according to the opinion of the collectors. Two or more of the skins are characterized by faint grayish lines on the throat and upper breast, which may be indicative of immaturity. In other respects there is nothing to reveal relative age. Variation in the white emargination of the dorsal feathers and in the intensity of the yellowish wash on the ventral surface seem to be determined by the extent of plumage wear.

Conopoderas æquinoctialis pistor (Tristram)

Acrocephalus pistor TRISTRAM, 1883, Ibis, p. 44, Pl. II (Fanning Island).

Tatare pistor, SHARPE, 1883, 'Cat. Birds Brit. Mus.,' VII, p. 527.

SUBSPECIFIC CHARACTERS.—Similar to *Conopoderas æquinoctialis æquinoctialis*, but larger, with more general whitish emargination of the dorsal plumage, and with more pronounced grayish wash on the throat and upper breast.

MEASUREMENTS.—(2 males): wing, 82, 79; tail, 69, 66; exposed culmen, 18, 17.8; bill from nostril, 13, 12.8; tarsus, 29, 28; middle toe with claw, 23 mm.

1 female: wing, 77; tail, 61; exposed culmen, 17.5; bill from nostril, 13; tarsus, 29 mm.

RANGE.—Fanning Island, Line Group.

Two adult males received from the Bishop Museum, Honolulu, and collected at Fanning Island, July 29, 1922, by S. C. Ball; one female lent by the Museum of Vertebrate Zoölogy, Berkeley, Calif., collected at Fanning Island, June 23, 1924, by H. Kirby.

Tristram published an excellent description of this warbler, which proves to be a larger race of the Christmas Island form. Except for size, the two subspecies are of nearly identical appearance, though two of the three specimens of *pistor* are of much lighter aspect on the dorsal surface, owing to the greater extent of the whitish feather edgings. The two males are in full moult and it is possible that the color difference between the two subspecies is one of season rather than one of pattern. In any event, the difference in size is striking.

Conopoderas æquinoctialis, subspecies?

The Museum of Vertebrate Zoölogy of the University of California has kindly lent a male specimen of a warbler of the *æquinoctialis* group, collected at Washington Island during the summer of 1924 by H. Kirby.

The skin is in bad condition, with a broken bill, but the bird seems to have been intermediate in size between the subspecies *æquinoctialis* and *pistor* It very probably represents a third race, confined to Washington Island, which lies well to the northwestward of Fanning Island in the direction of Palmyra. Further collecting will be necessary before the affinities of the Washington Island bird can be ascertained.

THE WARBLERS OF THE TUAMOTUS

About fifty islands of the Tuamotu (Paumotu) Archipelago were investigated during the course of the Whitney Expedition, and examples of *Conopoderas*, mostly in excellent series, were obtained at thirty-seven of them, in addition to specimens from the easterly outliers, Pitcairn and Henderson. It is fair to assume that members of this genus do not inhabit certain other islands in the group, on which Messrs. Beck and Quayle, and their Polynesian assistants, hunted with great thoroughness, but without encountering warblers.

In particular, the southeasterly clusters of the Tuamotus, such as islets of the Actæon and Gambier Groups (some dozen or more bodies of land), yielded no trace of warblers, although some of these support an abundance of other land birds, including fruit pigeons (*Ptilinopus*) and quail doves (*Gallicolumba*). According to our present information, no *Conopoderas* is known from any islet between Tureia (20° 45′ S., 138° 30′ W.) and Pitcairn (25° S. 130′ W.). The latter is perhaps not strictly to be included within the Tuamotu Archipelago; at any rate, the affinities of its endemic warbler are, as will appear, with the form occurring at one of the Austral Islands (Rimitara) rather than with the birds of the central and northwestern Tuamotus.

An alphabetical list of all the Tuamotu Islands represented by warblers in the Whitney Expedition collection is appended, together with their synonyms and their approximate geographical positions. The first name is, in most cases, that preferred by Brigham's 'Index to the Islands of the Pacific' (Mem. B. P. Bishop Museum, Vol. I, No. 2, pp. 87–256, 1900). In the systematic text only the first of the respective names is used.

Ahii, Ahe, Peacock	14° 30′ S., 146° 20′ W.
Ahunui, Fangataufa, Cockburn, Byam Martin	19° 40′ S , 140° 25′ W.
Anaa, Chain	17° 30′ S., 145° 30′ W.
Apataki, Hagemeister,	15° 30′ S., 146° 20′ W.
Aratika, Carlshov	15° 30′ S., 145° 30′ W.
Arutua, Rurick	15° 10′ S., 146° 50′ W.
Faaite, Faite, Miloradowitch	16° 45′ S., 145° 10′ W.

Fakahina, Fakaina, Akahaina, Predpriatie	16° S., 145° W.
Fakarava, Fakarawa, Wittgenstein	16° 10′ S., 145° 35′ W.
Hao, Hau, Bow, Harp	18° 15′ S., 140° 55′ W.
Hiti, Eliza	16° 45′ S., 144° 8′ W.
Katiu, Saken	16° 25′ S., 144° 20′ W.
Kauehi, Kawehe, Vincennes	15° 50′ S., 145° 10′ W.
Kaukura, Aura	15° 45′ S., 146° 45′ W.
Makatea, Metia, Aurora	15° 50′ S., 148° 12′ W.
Makemo, Makima, Phillips, Koutousoff	16° 35′ S., 143° 40′ W.
Manihi, Waterlandt	14° 30′ S., 145° 55′ W.
Matahiva, Lazareff	14° 55′ S., 148° 40′ W.
Napuka, Whytoohee	14° 10′ S., 141° 15′ W.
Niau, Greig	16° 10′ S., 146° 20′ W.
Nihiru, Niheri, Nigeri	16° 40′ S., 142° 50′ W.
Paraoa, Hariri, Gloucester	19° 10′ S., 140° 45′ W.
Rangiroa, Rahiroa, Vliegen, Deans, Nairsa	15° 10′ S., 147° 30′ W.
Raraka	16° 10′ S., 144° 55′ W.
Taenga, Holt, Jermaeloff	16° 10′ S., 143° 5′ W.
Tahanea, Tchitschagof	16° 50′ S., 144° 45′ W.
Taiaro, King	15° 45′ S., 144° 35′ W.
Takapoto, Oura	14° 40′ S., 145° 10′ W.
Takaroa, Tiokea	14° 30′ S., 144° 55′ W.
Takurea, Takoumé, Wolkonski	15° 50′ S., 142° 10′ W
Tepoto, Ofiti	16° 50′ S., 144° 10′ W.
Tikahau, Tikahao, Krusenstern	15° S., 148° 10′ W.
Tikei, Romanzoff	14° 55′ S., 144° 30′ W.
Toau, Elizabeth	15° 55′ S., 146° W.
Tuanaki, Tuanake, Reid	16° 40′ S., 144° 15 W.
Tureia, Carysfort, Papakena	20° 45′ S., 138° 30′ W.
Vanavana, Kurateke, Barrow, Teku	20° 45′ S., 139° 10′ W.

Wetmore (Bull. Mus. Comp. Zoöl., LXIII, No. 4, pp. 206–212) has already reported upon Tuamotuan warblers collected during a cruise of the 'Albatross' at ten different islands, of which the following three were not visited by members of the Whitney Expedition:

Akiaki, Thrum Cap, Lanciers	18° 30′ S., 139° 15′ W.
Pinaki, Nganati, Whitsunday	19° 20′ S., 138° 45′ W.
Hereheretue, St. Paul, San Pablo	19° 55′ S., 144° 55′ W.

The American Museum material from the Tuamotus, Pitcairn, Henderson, and from Rimitara of the Austral Group, to southward of the Societies, comprises about fifteen hundred specimens of *Conopoderas* taken at forty islands. The task of sorting, examining, comparing, and measuring these has been a large one, but the result, we hope, will justify the pains.

The Tuamotus, including Makatea, prove to be occupied by six races of a common species, three of which are here described as new.

These six are by no means of equal rank or equivalent range. Three of them (*erema*, *palmarum*, *niauensis*) are each confined to single islands; a fourth, the type form (*atypha*), occurs upon at least twenty-eight more or less contiguous islands; a fifth (*rava*) is found at a similar natural aggregation of seven or more islands in the east-central part of the Tuamotus. The sixth (*flavida*) inhabits one or more islands of the Disappointment Group, to northward of the main archipelago, and seems to have affinities with the warblers of the Marquesas Islands.

The typical subspecies, *Conopoderas atypha atypha*, which was described by Wetmore from Fakarava, ranges throughout most of the atolls between Matahiva on the west and Fakahina on the east. It is a somewhat nondescript and featureless bird, very puzzling because of a wide scope of coloration through brown, buffy, pale yellow, grayish, olive-green, and brownish olive, and, furthermore, because of the presence of two definite color phases which may be described roughly as "grayish" and "reddish." These phases appear in nestling plumage and are found apparently through all stages of the birds' life. Among our specimens are nestlings, juvenals, adults in fresh feathers, others in very worn plumage, and birds of both sexes with enlarged gonads or collected while incubating eggs or feeding young, which represent the respective color phases.

For these reasons, small series, such as have been previously available, would inevitably lead to confusion in a taxonomic study. It would be quite possible, for instance, that six or eight birds of only the brown type might be collected on one island, and as many of the greenish-gray type, with white breasts, on another. Under such circumstances it would be natural to describe the two as distinct races, a procedure which Wetmore, indeed, has followed. Our large series have rectified and balanced any such chance of error. For example, the criterion upon which we have worked out the distribution of *Conopoderas atypha atypha*, and have synonymized three of Wetmore's subspecific names, has been the presence upon any one of twenty-eight islands of birds indistinguishable in dimensions, pattern, and coloration from birds taken at other islands. In some cases the bulk of the specimens from two islands may chance to have different aspects, but there always prove to be certain examples from the respective localities that can be matched exactly, while any remaining discrepancies are blended out, and made to appear inconsequential, by specimens from still other islands. In short, the skins of *Conopoderas atypha atypha*, from the islands listed under the special discussion of that subspecies, make up a homogeneous series of birds, without a single character upon which to establish a difference or hang a name.

Conopoderas atypha atypha Wetmore

Conopoderas atypha atypha WETMORE, 1919, Bull. Mus. Comp. Zoöl., LXIII, p. 207 (Fakarava, Tuamotu Group).

Conopoderas atypha crypta WETMORE, idem, p. 209 (Makemo, Tuamotu Group).

Conopoderas atypha agassizi WETMORE, idem, p. 210 (Apataki, Tuamotu Group).

Conopoderas atypha nesiarcha WETMORE, idem, p. 210 (Rangiroa, Tuamotu Group).

MEASUREMENTS.—(134 males,[1] from the twenty-eight islands listed below): wing, 84–93 (88.3); tail, 68–83 (74.6); exposed culmen, 19.6–22 (21); bill from nostril, 14.3–17 (15.8); tarsus, 29–33 (30) mm.

79 females from all of the same islands save Katiu and Nihiru (twenty-six islands): wing, 81–90 (84.6); tail, 66–77 (71.1); exposed culmen, 19–22 (20.6); bill from nostril, 14.8–16.8 (15.6); tarsus, 28–31.5 (29.7) mm.

RANGE.—The northerly and westerly islands of the Tuamoto Archipelago, with the exception of Napuka, Anaa, Niau, and Makatea.

Specimens from the following twenty-eight islands of the Tuamotus: Fakarava, September, 1921, April, 1923; Aratika, December, 1922, May, June, 1923; Toau, April, June, 1923; Apataki, June, 1923; Kaukura, June, 1923; Rangiroa, August, 1922, June, 1923; Arutua, February, 1923; Tikahao, June, 1923; Matahiva, April, June, 1923; Tikei, August, December, 1922 Takapoto, August, 1922, February, March, 1923; Takaroa, February, March, 1923; Manihi, February, 1923; Ahii, August, 1922, February, 1923; Tahanea, March, 1923; Faaite, April, 1923; Kauehi, March, May, 1923; Raraka, March, 1923; Taiaro, May, 1923; Makemo, October, 1921, May, 1923; Katiu, May, 1923; Tuanaki, May, 1923; Hiti, October, 1921, May, 1923; Tepoto, May, 1923; Fakahina, October, 1921; Taenga, May, 1923; Nihiru, October, 1921; Takurea, May, 1923.

Wetmore's description of his specimens from Fakarava, Aratika, and Tikei (*loc. cit.*, p. 207) gives a good record of one phase of this highly variable race. To complete the picture, however, it is necessary to combine with the above his equally full and careful descriptions of specimens exhibiting different plumage variations, which he described under three other names, from the islands of Makemo, Apataki, and Rangiroa, respectively.

The following critical notes are drawn from an examination of twelve hundred specimens.

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[1] In this and certain other long series the dimensions of bill and tarsus are based upon slightly fewer specimens than those of wing and tail.

FAKARAVA.—Even the central rectrices are frequently tipped with whitish. There is, moreover, wide latitude in the extent of pale edgings on the dorsal plumage and in the general color tone, both of which are determined only in part by the extent of wear. In examples of the rufescent phase, the back and rump range between tawny-olive and snuff brown, while breast and flanks are often heavily tinged with clay color.

In young birds the rectrices are olive-brown, with only faintly paler edgings. The larger, whitish areas appear on these quills in a later plumage, after which one or two pairs of the outer feathers are often terminally whitish for a fifth or more of their length. Some adults show little more than a whitish speckling in the tail. Irregular albinistic feathers may appear on any part of the body.

ARATIKA.—There is a higher proportion of reddish birds than among those from Fakarava, but no dearth of counterparts among specimens in every plumage, including the grayest. Asymmetrical albinism is shown in the tail of one specimen. One immature male is extraordinarily yellowish, being washed with mustard or amber yellow on the breast; it is mainly tawny-olive on the upper surface, and has an olive-ochre tinge on cheeks and flanks.

TOAU.—The series matches the preceding two, though with more pronounced albinism, particularly of back, wings, and tail. As if to balance this, some adults have tails with absolutely no trace of white.

APATAKI.—Upon the basis of a single specimen Wetmore described the warbler of Apataki as *C. a. agassizi.* He compared his type not with specimens from the neighboring islands of Fakarava and Aratika, but with birds from Makemo, which lies in a southeasterly direction some one hundred and seventy-five geographic miles from Apataki.

Comparison of a large series of Apataki specimens with birds from Fakarava shows that the two are quite indistinguishable. Their variations are exceedingly similar, some birds from each island being very grayish on the back, with paler feather edgings, while others have more pronounced olivaceous and brownish casts. Others in each series show an almost pinkish wash on the breasts. Variation in the tail feathers is likewise of the type described above, and the measurements agree.

KAUKURA AND ARUTUA.—Seventy-five specimens from these two islands agree entirely with Fakarava birds.

RANGIROA.—Dr. Wetmore had six specimens from Rangiroa, upon the basis of which he described the warbler of that island as *C. a. nesiarcha*, comparing it with birds from Fakarava, etc. The characteristics given relate both to color and to proportions. He states that the Rangiroa form is more buffy below than typical *atypha*, that it averages more brownish above, and that the bill is distinctly shorter. Measurements given for the exposed culmen of his four male specimens are from 18.3 to 18.5 mm.

We can only assume that Wetmore's specimens were all immature birds of the rufescent phase, which, if a fact, might account both for the buffy suffusion and the shortness of the bill. At any rate, the last character is by no means shown in a series of sixty specimens from Rangiroa obtained during the course of the Whitney Expedition. The following figures represent the range in bill length of males from Rangiroa and from Fakarava, the type locality of *C. a. atypha.*

Rangiroa	20–20.8 (average, 20.45 mm.)
Fakarava	20–21 (average, 20.45 mm.)

Furthermore, grayish birds with light breasts, like many from Fakarava, are common in the series. Conversely, the buffiest Rangiroa specimen can be matched from any other island represented by a large series.

TIKAHAO AND MATAHIVA.—Warblers from these islands, at the extreme northwesterly end of the long line of the Tuamotus, also agree entirely with typical examples from Fakarava and its neighbors, as well as with those from Rangiroa and other intervening atolls. They include birds which are quite as grayish above and as whitish below as those from the type locality. The variations among both adults and immature harmonize completely, and the measurements offer no criteria for separation.

Nestlings and fledglings were taken during June.

TIKEI, TAKAPOTO, TAKAROA, MANIHI, AND AHII.—North of the western end of the Tuamotus lies this small line of somewhat isolated islands. The warblers from all of them agree closely, and a special effort was made, through close comparison and the measurement of a long series, to distinguish between them and the topotypical birds. The attempt was unsuccessful. The majority of specimens are brownish and buffy, but among those from Manihi and Ahii, especially, are some examples that are more than ordinarily "gray and white."

At Tikei, fledglings of the reddish phase were taken in December. Adults of both phases were breeding between August and December. From Takapoto are nestlings taken in March and actively breeding adults taken in August. At Ahii, a female was collected on her eggs on February 6, and non-breeding adults during August.

FAAITE AND TAHANEA.—These atolls lie southeast of Fakarava, close to the latter and to each other. The birds of all are counterparts in appearance and measurements.

At Faaite, half-grown nestlings which are perfect examples of the reddish and the grayish phases, respectively, were taken on the same date in April. The distinction is as independent of sex and age as of locality, and is thus demonstrated to be a purely individual variation. The genetic significance, if it could be worked out, would be exceedingly interesting.

KAUEHI, RARAKA, AND TAIARO.—Birds from these islands, which lie northeast of Fakarava, are true to type. The Raraka series includes a male taken on March 10, 1923, which has six asymmetrically placed albinistic rectrices, several partially albino quills in each wing, and a rump and upper tail-coverts which are Isabella color. The last is an expression of a strong underlying character in the genus (Cf. *Conopoderas atypha flavida*, *Conopoderas caffra fatuhivæ*, etc.).

Among the Kauehi birds are March fledglings of the two phases already described. In the Taiaro series, also, are both gray and rufescent female chicks, taken from nests on May 28 and 29. The hue of the reddish example is close to the snuff brown of Ridgway's 'Color Standards.' Several May adults from Taiaro are in full moult, tail-less, and with only pin-feathers on the head and throat.

MAKEMO.—Wetmore described the warbler of Makemo, in the central part of the Tuamotu Archipelago, as *C. a. crypta*, stating that it differed from the typical form in being "distinctly grayer above, and whiter, less buffy, below."

We can only conclude, again, that the observed difference depended on the smallness of his series. The Whitney Expedition collection includes a large number of skins from Makemo, and in measurements, coloration, and range of variation they are quite indistinguishable from birds of Fakarava. Five characteristically gray adults from each island were carefully examined by several members of the Department of Birds in the American Museum, and absolutely no racial differences, however slight, could be discriminated. Dr. Wetmore also speaks of strongly rufescent examples in the Makemo series. These, are likewise present among our birds, but they can be matched, skin for skin, among the warblers from Fakarava and from many of the other islands already considered.

Fledglings of the grayish phase are dated May 21. Both grayish and rufescent adults were breeding during the same month, while still other adults were undergoing heavy moult.

KATIU, TUANAKI, HITI, AND TEPOTO.—These four islands make up the so-called Sea Gull or Raeffsky Cluster of the Tuamotus, lying between Makemo on the east and Raraka and Tahanea on the west. Tepoto is not to be confused with the more northerly island of Tetopoto or Otooho, in the Disappointment Group, which is incorrectly labelled "Tepoto" on many hydrographic charts.

The warblers, as might be expected, agree with those of the surrounding islands. A male from Hiti is the most thoroughly albinistic example yet mentioned, with the head and a large part of the back creamy white, speckled with a few dark feathers, and with an isabelline patch on the left side of the neck. The quills are irregularly spotted with white, but no more so than among many otherwise normal specimens. One example from Tuanaki, a male collected on May 3, is the yellowest noted throughout the entire subspecies. The under surface of this bird, from throat to belly, is washed with Naples yellow, and the flanks and crissum with a color ranging from cream-buff to chamois.

Breeding adults were collected at Katiu, Tuanaki, and Hiti during May, and at the last-named island during October as well.

FAKAHINA.—This is an isolated island, lying one hundred and twenty-five miles east of Takurea and one hundred and fifty or more miles northeast of Hao. It is the eastern outpost of a natural chain extending from Matahiva through the line of islands previously discussed, and its warblers are absolutely indistinguishable from Fakarava birds. The Fakahina series comprises only five specimens, and these all of the gray phase. Four of them have white under-surfaces and one shows a faint yellowish tinge. Albinism is conspicuous in two specimens. It so happens that our entire series from Takurea, the nearest island to Fakahina, is made up of six birds in the rufescent or buffy phase. It is easy to understand, therefore, how a systematist with only these two series to compare might justifiably describe them as distinct subspecies. Only when we find birds of both types present in large numbers from neighboring islands do we realize the pitfalls.

TAENGA.—Specimens from Taenga are absolutely typical of the subspecies, agreeing equally with those from such remote localities as Fakarava to westward and Fakahina to eastward. Non-breeding adults, many undergoing complete moult, were taken during May.

Nihiru and Takurea.—Nihiru is represented by but one skin, an adult male taken in October, and in breeding condition. From Takurea we have an excellent series of May birds, mostly with inactive gonads, although at least one was nesting.

We have grouped the specimens from these two islands under *Conopoderas atypha atypha*, with the characters of which most of them substantially agree, but it must be confessed that some of the birds would be hard to distinguish from the subspecies *rava*, which inhabits the group of islands lying to southeastward. Such apparent evidence of intergradation is quite in harmony with the theory of subspecies, and the geographic proximity of the areas of uncertainty is interesting, not to say gratifying. The same degree of doubt applies to the warblers of Hao, which we have aligned with *Conopoderas atypha rava*, but which occupy the island of the other assemblage that lies nearest Nihiru and Takurea.

The habitats of the races *atypha* and *rava* differ somewhat in quality as well as in geographic position. Most of the islands occupied by the former are large, well-wooded atolls. The islands inhabited by *rava*, on the contrary, are very small, Hao being the only exception. When the bird life of the whole region is better known, through further study of the Whitney Expedition material, an interpretation of such relationships may become possible.

It has not been thought worth while to give detailed measurements of specimens from the separate islands considered above. Suffice it to say that these were all made and carefully compared by the senior author, and that the sums from which averages were derived were reckoned on a computing machine by his assistant, Miss Dorothy Taylor. The fact that the incomparable collection of Tuamotuan warblers were prepared by the same field workers during a recent and relatively short period of time, and that the skins are all of the same "make," has been of great advantage in working out the relationships and variations of these puzzling birds.

From notations on the labels of *Conopoderas atypha atypha*, one is forced to the conclusion that the birds breed throughout the year. At any rate, a tabulation of the condition of the gonads, in warblers from practically all islands within the range, proves insufficient to give a clue to any relation between season and the height of the breeding period. Adults in all sexual stages, as well as nestling birds, are noted for the following months: February, March, April, May, June, August, October, and December. Change of plumage likewise seems to have no reference to time of year. Many specimens noted as still caring for their young were actively moulting. Not infrequently the feathers undergo extraordinary wear before the beginning of the moult. Among our series are a number of pitifully bleached and threadbare birds, with body feathers and quills abraded almost to shreds.

Males heavily outnumber females among specimens from all but one of the twenty-eight islands listed. The ratio of sexed birds for all of these localities is 804 males to 404 females, or a proportion of two to one. This may be partly explained by greater conspicuousness of the males because of their singing and their greater freedom during the period of incubation. It is probable, however, that males do actually outnumber females.

In this, and all other forms of *Conopoderas* examined, males average consistently larger than females, particularly in the length of wing and tail Notes on the labels of this and the three following subspecies record the iris as brown, bill blackish above, horn-color on the mandible, feet and legs "gray."

Conopoderas atypha palmarum, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Conopoderas atypha atypha*, but distinguishable by its slightly smaller size.

TYPE.—No. 190,439, Amer. Mus. Nat. Hist.; ♂ ad.; Anaa Island, Tuamotus; October 21, 1921; R. H. Beck.

MEASUREMENTS.—(5 males): wing, 85–89 (86.8); tail, 68.6–73.3 (71.6); exposed culmen, 18.5–19.7 (19.2); bill from nostril, 14.2–14.7 (14.5); tarsus, 28.3–29.3 (28.9) mm.

5 females: wing, 79.6–82.5 (80.8); tail, 60–68 (63.2); exposed culmen, 16.5–18.5 (17.5); bill from nostril, 12.5–13.8 (13); tarsus, 27–29 (28.3) mm.

RANGE.—Known only from Anaa Island.

Specimens from Anaa, collected during October, 1921.

Only eleven examples of the resident warbler of Anaa were obtained, five males, six females, but these comprise adults with large gonads and two or more nesting birds. The series includes both gray and rufescent phases, and the specimens present no feature of plumage to distinguish them from the typical form. The fact that none of the Anaa skins has any entirely white tail quills is probably due only to chance, and the smallness of the representation.

The size difference is, however, perfectly constant, even though slight. It shows in every dimension, but particularly in the bill; the maximum length of culmen among five males of *palmarum* is about the same as the minimum length among 134 males of *atypha*. To put the matter another way, the size range in MALES of *palmarum* is lower than that in FEMALES of *atypha*.

Anaa lies in a somewhat isolated position, about forty geographic miles south of the nearest points of Tahanea and Faaite. It is a much-broken atoll, which doubtless accounts for its other name, Chain Island. The axis lies in the trade-wind direction. In 1874 the islets on the reef supported seven million coconut palms.

The fact that the endemic warbler of Anaa is so much less distinct a geographic race than the bird of Niau, which lies much closer to atolls inhabited by the typical form, is one of the puzzling problems that continually challenge the taxonomist and zoögeographer.

Conopoderas atypha niauensis, new subspecies

SUBSPECIFIC CHARACTERS.—Distinguishable from *Conopoderas atypha atypha* by its much smaller size (distinctly smaller than even the subspecies *palmarum*, especially in size of bill); and from both *atypha* and *palmarum* by the absence of appreciable whitish tips and borders on the quills and coverts, the great reduction of pale emargination on the back, the obsolescence of the loral-superciliary stripe, and the apparent absence of albinism.

TYPE.—No. 199,952, Amer. Mus. Nat. Hist.; ♂ ad.; Niau Island, Tuamotus; September 13, 1921; R. H. Beck.

MEASUREMENTS.—(17 males): wing, 82–87 (85.7); tail, 70–74 (71.4); exposed culmen, 18–18.8 (18.4); bill from nostril, 13–14.6 (13.7); tarsus, 27–28.5 (28) mm.

3 females: wing, 79–80 (79.3); tail, 62–69 (65); exposed culmen, 18–18.8 (18.4); bill from nostril, 13; tarsus, 28.5–29 (28.7) mm.

RANGE.—Known only from Niau Island.

Specimens from Niau, collected during September, 1921, and August, 1922.

Most of the examples are breeding adults, with enlarged gonads. Small size is undoubtedly the certain character for the recognition of this race, but the nearly unicolor aspect of the dorsal surface among the whole series of twenty-three specimens, the absence of the familiar albinistic quills and scattered white body feathers, and the supression of most other light or whitish markings, are probably also significant. The general feathering of the back, moreover, is of an olive-buff cást which is subtly different from the color of the two preceding subspecies, and is rarely matched in the large and highly variable series of *atypha*. In ventral aspect none of the Niau birds approaches the whiteness of *atypha* in "gray" phase, all of our specimens being tinged on the breast, belly, and flanks with cream color and tones of buff.

Niau is a small, continuous, heavily wooded atoll, lying about equally close to each of the larger chain-atolls of Fakarava, Toau, and

Kaukura. The three latter share the subspecies *Conopoderas atypha atypha*, and it was, naturally, surprising to find a distinct and smaller race occupying Niau. It should be recalled that Niau is also the home of an endemic kingfisher (*Todirhamphus gertrudæ*), the only member of its family thus far known from the Tuamotus. Perhaps this small island has more faunistic peculiarities than have hitherto been suspected.

Conopoderas atypha rava Wetmore

Conopoderas atypha rava Wetmore, 1919, Bull. Mus. Comp. Zoöl., LXIII, p. 208 (Pinaki or Whitsunday Island, Tuamotu Group).

Measurements.—(39 males, from Pinaki, Akiaki, and the five other islands listed below): wing, 84–93 (89.3); tail, 71–80 (76.2); exposed culmen, 20–22 (21); bill from nostril, 15–16.8 (16); tarsus, 30–31.8 (30.9) mm.

23 females, from six of the same islands: wing, 82–88 (85.2); tail, 67–77 (71.3); exposed culmen, 19.2–21.6 (20.4); bill from nostril, 15–16.6 (15.9); tarsus, 28.5–30.8 (29.5) mm.

Range.—Seven or more islands in the southeastern part of the Tuamotu Archipelago.

Specimens from Vanavana, Tureia, Ahunui, and Paraoa, June, 1922, and Hao, October, 1921.

The type and its associated specimens have been kindly lent by Dr. Wetmore. They prove to be indistinguishable from our birds taken at a half circle of islands which lie from south to northwest of Pinaki, at distances ranging between eighty and about one hundred and forty geographic miles. The type is, fortunately, a "typical" and average specimen, with the following dimensions, according to our own measurements: wing, 89; tail, 74; exposed culmen, 21.3; bill from nostril, 15.5; tarsus, 30.8 mm.

Wetmore states that this race is "similar to *Conopoderas atypha atypha*, but under surface washed with massicot yellow, under tail coverts averaging paler, less buffy, and superciliary stripe massicot yellow, most obscure anteriorly." The above is substantiated by our series of seventy-five specimens, except that the under tail coverts are not paler or less buffy than in typical *atypha*. On the contrary, they are rather consistently darker and buffier throughout the series of *rava* than is usual in the subspecies *atypha*. Moreover, the statement that "the under surface is washed with massicot yellow" is distinctly true of only the more brightly colored examples, perhaps one third of the entire series, for variation is very great, and it runs through much the same gamut with reference to color phases, albinism, etc., as in the race of the western Tuamotus. Certainly, however, the birds from the southeastern islands are on the whole both browner on the dorsal surface and yellower or buffier beneath than any equal number of specimens of *C. a. atypha.* There is not a single example of the definitely gray and whitish birds, such as can be picked out among specimens from Fakarava, or from almost any one of the other northerly islands lying between Matahiva on the west and Fakahina on the east. In short, *C. a. rava* is a "weak" but perfectly acceptable geographic subspecies, with a definite suggestion of intergradation apparent among examples from Hao, which, appropriately enough, is the island of the southeastern group lying nearest to Nihiru, Makemo, Taenga and other islands occupied by the race *atypha.* Hao, furthermore, is a huge, elongate atoll, with a lagoon more than a hundred square miles in extent. It is similar to a majority of the islands inhabited by *atypha,* but very different from the others within the range of *rava.*

Wetmore's detailed description of this form is excellent. Several of our brightest specimens show a deeper yellow on the breast than that of his birds (close to straw or Naples yellow), but the individual variation is of wide range in this as in other characters.

No great numerical discrepancy between the sexes appears in the series of *C. a. rava.* Of 68 labels bearing positive sex determinations, 38 are marked male and 30 female. Birds from Paraoa, Tureia, Ahunui, and Vanavana had small gonads in June, with a few at the last-named island still caring for nestling young. Birds taken at Hao during October had enlarged testes and ovaries.

Conopoderas atypha erema Wetmore

Conopoderas atypha erema WETMORE, 1919, Bull, Mus. Comp. Zoöl., LXIII, p. 211 (Makatea, Tuamotu Group).

MEASUREMENTS.—(10 males): wing 88–95 (92.3); tail, 75–84 (80.6); exposed culmen, 22.6–25 (24); bill from nostril, 17.5–18.6 (18); tarsus, 31–32 (31.5) mm.

8 females: wing, 85–92 (88.9); tail, 74–79 (76.6); exposed culmen, 23.5–24 (23.8); bill from nostril, 16.8–17.2 (17); tarsus, 29.5–30 (29.8) mm.

RANGE.—Restricted to Makatea Island.

Specimens from Makatea, collected during August, 1922.

This very distinct form is admirably treated by Wetmore, whose description and comments are indispensable. Thirty specimens, of which eighteen were definitely sexed as males and eight as females, were taken by members of the Whitney Expedition. The gonads were in various stages, from inactive to large, during August, and several apparently juvenal specimens had attained full growth.

The Makatea bird differs from typical *atypha* not only in its larger size but also in the consistently more cinnamomeous hue of the entire plumage. When large series are compared, the distinction is very striking; even the most rufescent examples among the subspecies *atypha* and *rava* are slightly less richly colored on the ventral surface, and decidedly less in dorsal aspect, than average specimens of *erema*. Moreover, the bill of *erema* is not only longer than that of all the subspecies previously treated, but it is also slightly more decurved. The familiar type of variation in the color of the rectrices is, however, apparent in the Makatea form, some specimens showing quills almost entirely olive-brown, while in others the outer feathers are white-tipped, and in still others all but a few central rectrices are entirely white. Albinistic feathers frequently crop out in other parts of the plumage.

Wetmore calls attention to the manner in which *erema* approaches *C. caffra* of Tahiti, etc. We agree with him, however, in aligning *erema* with the Tuamotuan birds rather than with those of the Society Group. Wetmore speaks, furthermore, of the isolated position of Makatea with reference to the bathymetric curve of the ocean bottom. We might add that Makatea, being an uplifted coral, and forested, island, is also topographically set apart from the remaining Tuamotus, and has rather close faunal affinities with the Societies. For example, it shares a large pigeon (*Globicera auroræ*) with Tahiti, while its small fruit pigeon (*Ptilinopus chalcurus*) is endemic, and is quite distinct from the form widely distributed among the atolls of the Tuamotus (Cf. Murphy, Amer. Mus. Novit., No. 124, p. 1). It may be questioned whether Makatea should be included within the Tuamotu Group, despite the fact that it lies so close to Rangiroa.

Conopoderas atypha flavida, new subspecies

SUBSPECIFIC CHARACTERS.—A large and very distinct form, differing from typical *atypha* in its longer wing and much longer bill, and from all the Tuamotuan forms thus far described in the strongly yellow tone of the entire ventral surface from chin to tail coverts.

ADULT MALE.—Pileum, nape, back, and scapulars brownish olive, darkest on the crown, the feathers from neck to lower back faintly margined with yellowish olive, giving a greenish cast to fresh plumage; rump and upper tail coverts, dark olive-buff, making a decided contrast with the back; quills of wing and tail, mummy brown, tipped and externally margined with whitish or cream color; on the wing, the borders increase in width inwardly to the tertials and greater coverts; outer rectrices with irregular whitish terminations, in some specimens covering most of the inner web of the outermost quills; supraorbital stripe, pale yellow, extending forward through lores to nostril; cheeks and entire under surface, barium yellow, invaded slightly at the sides of the neck by olivaceous feathers; lining and bend of wing, barium yellow. Iris, brown; bill, brown above, flesh color on mandible; legs and feet, gray.

TYPE.—No. 195,802, Amer. Mus. Nat. Hist; ♂ ad; Napuka Island, Tuamotus; December 11, 1922; R. H. Beck.

MEASUREMENTS.—(3 males, 1 sex undetermined): wing, 92–95 (93); tail, 73–78.5 (75.2); exposed culmen, 23 8–24 (24); bill from nostril, 17.7–18 (17.9); tarsus, 30–31.7 (31) mm.

RANGE.—Known only from Napuka Island in the Disappointment Group of the Tuamotus.

Specimens from Napuka collected during December, 1922.

Three of the specimens seem to be less mature than the type. One is browner on the back, with a buffy wash along the flanks and sides of breast, and with a darker rump than fully adult birds. The yellow of the breast is also paler in this specimen. All four skins, however, are marked as "breeding" or "nesting."

In dorsal aspect, this race has the characteristic "brown" appearance which is so common among other Tuamotuan warblers. It can be matched by examples of typical *atypha*. The hue of the quills, however, is richer than in most birds of the latter race, while the yellow of the under surface, the great length of the bill, and the conspicuously light rump recall some of the subspecies of *Conopoderas caffra* which inhabit the Marquesas Islands, about three hundred miles to northward. In fact, *flavida* resembles especially the race of Fatuhiva, the nearest of the Marquesas.

Napuka lies in an isolated position north of the central Tuamotus, about one hundred and fifteen geographic miles from Takurea and more than that from Fakahina. It is a well-wooded island, with human inhabitants said by the older authorities to be a "distinct race" from the people of the other Tuamotus. In its endemic *Conopoderas* we have, possibly, a clue of much zoological significance, for while the warblers of the western Tuamotus are so distinct from *caffra* of the Societies, we find at Napuka a form suggestive of *caffra* of the Marquesas. Perhaps all the races of these three great insular groups should be recognized as a single Formenkreis. In view of our inadequate series from Napuka, and because of our lack of knowledge of the warblers of Tetopoto and Pukapuka, the question may be reserved for future consideration.

THE WARBLERS OF PITCAIRN AND HENDERSON ISLANDS, AND THE AUSTRAL GROUP

Thorough ornithological investigation of the Austral Islands, which lie well to southward of the Societies, and near the Tropic of Capricorn, was undertaken during the Whitney Expedition, but a warbler was found only at the island of Rimitara. Curiously enough, this bird, which is new to science, has its affinities neither with the species of the Society Islands, nor with that of the Tuamotus, but proves to be very closely akin to the warbler of Pitcairn Island, which is situated twenty-two degrees of longitude to eastward and two and a half degrees farther southward. The latitudinal relationship in the ranges of these two birds is of extraordinary geographic interest.

The species *Conopoderas vaughani* is set well apart from other Polynesian members of the genus by at least one structural characteristic, namely, the greater proportionate length of the tarso-metatarsus. When arbitrary graphs, illustrating the average ratios of bill, tarsus, tail, and wing, are plotted for the various races of *æquinoctialis*, *caffra*, and *atypha*, they prove to resemble one another very closely; the size range is large among these several forms, but proportions remain substantially the same. Similar data based on each of the three subspecies of *vaughani* give a curve of different contour, owing to the relative elongation of the tarsus.

For example, the bill length in males of *Conopoderas vaughani vaughani* averages about 11.5 per cent greater than that in males of *Conopoderas æquinoctialis æquinoctialis*, while the disproportion in length of tarsus amounts to 25 per cent. Again, the wing and bill in males of *Conopoderas atypha atypha* average, respectively, 8 per cent and 19 per cent longer than the same members of *Conopoderas vaughani vaughani*, while the tarsus in these two forms is of the same absolute length.

The color characters of the races of *vaughani* are curious, for while the warblers of Pitcairn and Rimitara are almost facsimiles of each other, that of Henderson Island, which is only one-tenth as far from Pitcairn, differs markedly from the other two. All three subspecies are chronically albinistic, no adult specimens of the Henderson bird being without a fair sprinkling of white feathers on the head and back, whereas in the other two the albinism tends to concentrate in the wings and tail.

The Henderson Island warbler was described in 1913 as a new species, *Acrocephalus taiti*. Its genetic relation to its neighbor on Pitcairn Island has not, however, been pointed out. The Henderson bird is a perfect example of what Duncker has termed an "alipochrome," which means that the activator for yellow pigment is lacking from its germ plasm. In effect, the Henderson warbler is the Pitcairn warbler deprived, through saltation, of its lipochrome, and segregated as a pure strain on another island, with no further opportunity of back-crossing. The whole subject of color inheritance in canaries, including many examples of inheritable characters that appear as mutants in wild birds,

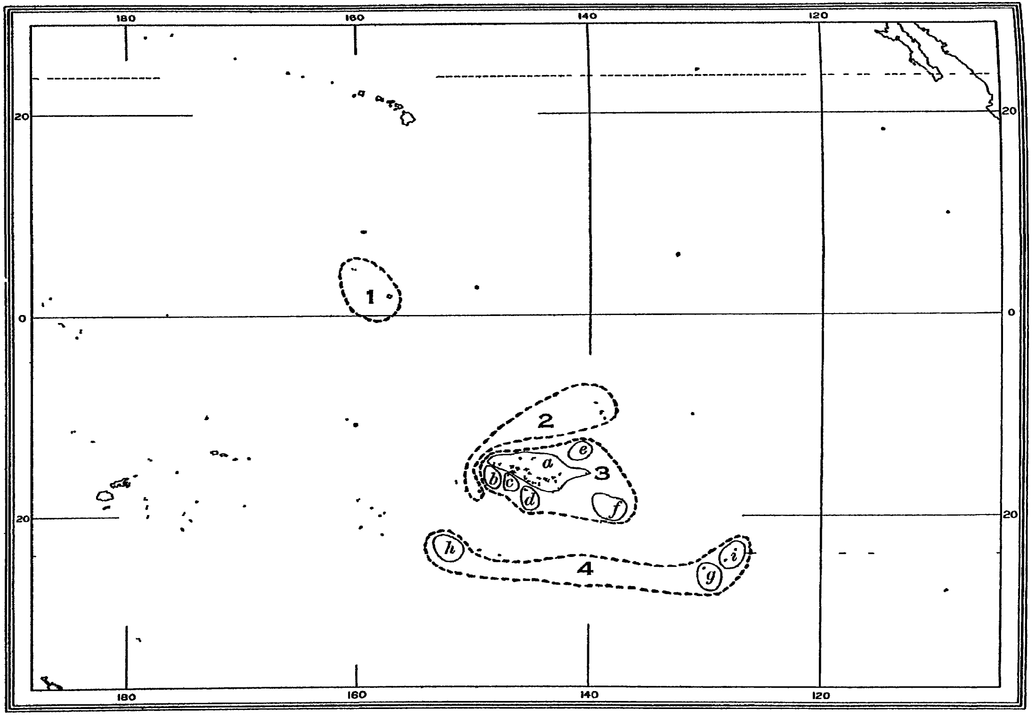

Fig. 1. Distribution of four species of *Conopoderas* in Polynesia.

1. *Conopoderas æquinoctialis* (2, or 3, subspecies, Line Islands) 2 *Conopoderas caffra* (2 subspecies at the Society Islands, 8 at the Marquesas Islands) 3 *Conopoderas atypha* (6 subspecies at the Tuamotu Islands: a, *atypha*, b, *erema*, c *niauensis*, d, *palmarum*, e, *flavida*; f, *rava*). 4. *Conopoderas vaughani* (g, *vaughani*, Pitcairn Island, h, *rimitaræ*, Rimitara Island, i, *taiti*, Henderson Island).

For distributional and systematic data on *Conopoderas caffra*, see Murphy and Mathews, 1928, Amer Mus. Novit., No 337, pp. 9–18.

is reviewed by Duncker (1928,'Genetik der Kanarienvögel,' Bibliographia Genetica, IV, pp. 37–140).

Conopoderas vaughani vaughani (Sharpe)

Tatare vaughani SHARPE, 1900, Bull. Brit. Ornith. Club, XI, No. LXXIV, p. 2 (Pitcairn Island, South Pacific).

ADULTS (sexes alike).—Pileum, dark olive, each feather distally margined with cream-buff, producing a scaled appearance; back, scapulars, and sides of neck, olive, the feathers bordered like those of the crown, but more finely; on the rump, the cream-buff terminations are very broad, covering most of the exposed part of each feather; upper tail-coverts, chiefly Isabella color, with darker shafts, but varying sporadically toward hair brown and toward an albinistic condition; rectrices, when and where dark, approximately fuscous, tipped with white, but in most specimens the tail is from one-half to entirely albinistic, in which case the shafts are white and the vanes vary from white to naphthalene yellow; no district supraorbital stripe, but a few feathers of colonial-buff hue on the upper eyelid; wings, irregularly but prevailingly albinistic, like tail, the white quills being tinged on their outer webs with naphthalene yellow; when dark, the remiges and their coverts are fuscous, bordered externally with cinnamon-buff, cream-buff, or whitish; lining of wing, whitish or creamy, mottled with dark feathers; cheeks, olive, with lighter feather-edgings; ventral surface, from throat to belly, yellow (straw yellow at points of maximum intensity) but usually mottled by the effect of the concealed, dark mouse gray portions of the feathers; flanks, faintly tinged with cream-buff; feathering of thighs, Isabella color; under tail-coverts, cream-buff. Iris, brown; bill, blackish, flesh color on mandible; legs and feet, "grayish."

MEASUREMENTS.—(7 males): wing, 80–84.8 (82); tail, 68–73 (70); exposed culmen, 17–18 (17.6); bill from nostril, 13–13.3 (13.1); tarsus, 29–30.8 (30) mm.

4 females: wing, 74–78 (75.3); tail, 64–66 (65); exposed culmen, 16.8–17.6, (17.2); bill from nostril 12.7; tarsus, 28.6 mm.

RANGE.—Pitcairn Island (25° 3′ S., 130° 8′ W.).

Specimens from Pitcairn Island, March, 1922.

Birds in juvenal plumage are browner above, buffy (cinnamon-buff to honey-yellow) on the ventral surface, and with practically no trace of albinism. Adults, on the other hand, are universally albinistic, if that is the proper term to apply to the condition. Only one adult in the series has a full complement of dark rectrices with narrow whitish tips.

No specimen was in breeding condition on the dates of capture.

Conopoderas vaughani rimitaræ, new subspecies

SUBSPECIFIC CHARACTERS.—Similar in all stages of *Conopoderas vaughani vaughani*, but larger, slightly greener on the dorsal surface (between deep olive and dark olive), and, apparently, characterized by still more extensive albinism, which frequently involves the back, sides, and head, as well as the wings and tail. Even juvenals sometimes exhibit albinism of the rectrices.

TYPE.—No. 190,503, Amer. Mus. Nat. Hist.; ♂ ad.; Rimitara Island, Austral Group; March 29, 1921; E. H. Quayle.

MEASUREMENTS.—(6 males): wing, 81–88 (84.3); tail, 65–76 (71.6); exposed culmen, 17.8–20 (18.6); bill from nostril, 13–14.6 (13.5); tarsus, 29.2–32 (30.6) mm.

6 females: wing, 79.5–84 (82); tail, 67 5–74 (71.1); exposed culmen, 17–19 (18.2); bill from nostril, 13–14.3 (13.7); tarsus, 29 mm.

RANGE.—Rimitara Island, Austral Group (22° 40′ S., 152° 45′ W.).

Specimens from Rimitara, collected during March and April, 1921.

The birds are very nearly counterparts of the Pitcairn form, except for their slightly but consistently larger size and greater albinism. They were mostly in non-breeding condition, but a few are marked as having swelling gonads. Flesh colors are as in the type form.

Other islands of the Austral Group were thoroughly scoured by the Whitney Expedition collectors, but warblers were found only at Rimitara.

While it is hopeless to speculate on the distributional relationships of these two barely separable races, the possibility of the transfer of the ancestors of one of them through human (Polynesian) agency can hardly be ruled out.

Conopoderas vaughani taiti (Ogilvie-Grant)

Acrocephalus taiti OGILVIE-GRANT, 1913, Bull. Brit. Ornith. Club, XXXI, No. 185, p. 59 (Henderson Island, South Pacific); Ibis, 1913, p. 345.

SUBSPECIFIC CHARACTERS.—Differs from *Conopoderas vaughani vaughani* in the practical suppression ot olivaceous color in the dorsal plumage, and of yellow in the ventral plumage; *taiti* is a little darker than hair brown on crown and back, and whitish, faintly tinged with buff, below. Moreover, albinism is more thoroughly disseminated throughout the dark body plumage, and rather less general in the quills, than in either of the preceding races.

MEASUREMENTS.—(6 males): wing, 80–84 (82.1); tail, 69–73 (71); exposed culmen, 16.5–17.8 (17); bill from nostril 12–13.5 (12.3); tarsus, 28–30 (29.5) mm.

4 females: wing, 77.5–82 (79.6); tail, 67–73 (70); exposed culmen, 16.8–18 (17.5); bill from nostril, 12.7–14.7 (13.3); tarsus, 28–28.6 (28.3) mm.

RANGE.—Henderson, or Elizabeth, Island (24° 21′ S., 128° 19′ W.).

Specimens from Henderson Island, collected during March and April, 1922.

The describer, Ogilvie-Grant, gave a good account of this interesting warbler, which differs from the Pitcairn bird chiefly in the absence of color. Juvenals of the two resemble each other very closely indeed, those of the Henderson form being only slightly paler than the young of the other subspecies. Albinism in *taiti* centers about the anterior, rather than the posterior, end of the body, the back and head being shot through with white feathers. Many adults are, in fact, prevailingly white-headed, while the quills of wing and tail are often mostly dark.

The adults were not in breeding condition on the dates collected. Flesh colors were as in the other two forms. Ogilvie-Grant reported that the iris of the female is "red," which sounds like a solecism and does not agree with Beck's notes.

AMERICAN MUSEUM NOVITATES

Number 351
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
May 8, 1929

59 79 D.11 61, 62

THE SPERMATOPHORES OF *DESMOGNATHUS* AND OTHER PLETHODONTID SALAMANDERS

BY G. K. NOBLE AND J. A. WEBER

The Plethodontidæ form the dominant group of North American salamanders and yet very little is known of their spermatophores or method of impregnation. Bedriaga (1897) reported that *Hydromantes italicus* kept in a terrarium deposited spermatophores on the ground in October. Wilder (1913) found, in May, spermatophores in the cloacas of two females of *Desmognathus fuscus fuscus.* One of these females a moment previously was noted among wet leaves in the terrarium with its ventral surface pressed against that of a male. In a later paper Wilder (1923) reported an additional instance of a spermatophore being found within the cloaca of a female. The salamander was sexually immature and one of ten or twelve which had been "kept unassorted in shallow water in a covered glass crystallizing dish until May 20, when it was observed that in the water, which looked rather foul, there were several creamy white masses of irregular shape, measuring about one millimeter in diameter."

Microscopical examination revealed these masses to be spermatophores, but it was not possible to determine whether the spermatophore in the female's cloaca had been picked up in the water after deposition by the male. Wilder concludes that "if such be the case, it is probable that both the direct and the indirect method of impregnation of the female obtain in this species, the former operative when individuals find themselves under purely terrestrial conditions, the latter, which is of course the more primitive method, being employed under aquatic conditions." Very recently Blanchard (1928) has described the spermatophores of *Plethodon cinereus* as "nothing more than sacs or bags filled with sperm" which are "tucked closely into the posterior part of the cloaca" of the female from October 31 to December 9. During the past year we have made observations on the spermatophores of several plethodontid salamanders. We find ourselves in disagreement with various details given by Wilder and by Blanchard. Further, our observations include additional species and extend the account of the process of impregnation of the female plethodontid salamander as given by these investigators.

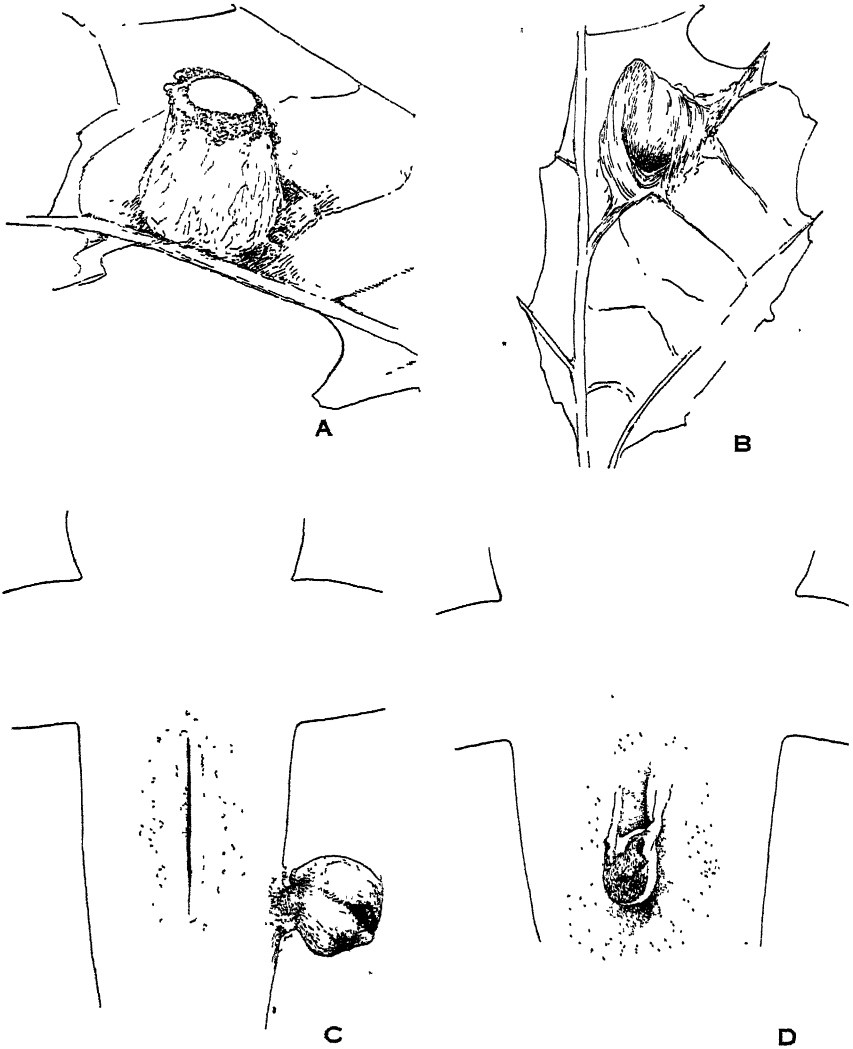

Fig. 1. The spermatophore of *Desmognathus fuscus*. ×15.

(*a*) The complete spermatophore attached to a leaf.
(*b*) The base of a spermatophore after its head had been removed.
(*c*) The head of a spermatophore adhering to the tail of a male *Desmognathus fuscus*.
(*d*) The spermatophore head attached in its normal position to the cloacal lips of a female *Desmognathus fuscus*.

On June 16, 1928, several adult *Desmognathus fuscus fuscus* were collected in a very cold spring near Delaware Water Gap, Pa., and placed in a covered, glass dish half filled with water. Moss and well-leached leaves were added until they came just above the level of the water. On the morning of June 18 several freshly deposited spermatophores were found attached to the moist leaves which protruded above the water. It was assumed that the sudden change of temperature might have induced a premature deposition of spermatophores and as a result these might not be typical in form. But on the evening of June 28 two additional spermatophores were attached to leaves above water and these agreed in structure with the others, although the series exhibited some variation in form.

All spermatophores were attached to wet leaves out of water. The point of attachment was always near one of the leaf-ribs usually at the point of intersection of two such ribs. The fresh spermatophore had a glassy, transparent base surmounted by a small whitish cap (Fig. 1*a*). The spermatophores were not "creamy white masses of irregular shape" such as Wilder (1923) described in her aquatic *Desmognathus*. One spermatophore (Fig. 1*b*) lacked the white cap, due apparently to its having been removed by a female, although unfortunately at this date the cloacas of the females were not examined. It was apparent that *Desmognathus* agrees with *Ambystoma* and *Triturus* in producing stalked spermatophores, but these are deposited above the surface of the water on leaves. Each spermatophore has the same two parts as those of *Ambystoma* and *Triturus* but its shape is different. The base is wider than that of the newt (Jordan, 1893) and the head proportionately narrower than in spermatophores of either genus.

No further opportunity was had for studying spermatophores of *Desmognathus f. fuscus* until October 28, when Miss Gertrude Evans brought us a series of adults collected the previous day at Morristown, N. J. One of the females was found to have a whitish mass filling nearly the entire orifice of the cloaca. This was obviously homologous to the head of one of the spermatophores described above. It contained active spermatozoa and was sectioned to show the relation of the sperm to the whitish material. Before discussing this relationship some reference may be made to other spermatophores obtained.

On November 9, 1928, Mr. W. G. Hassler brought us a series of adult *D. f. fuscus* collected the previous day in Yonkers, New York. One large female as shown in figure 1*d* had a spermatophore protruding from the cloaca. The head inserted within the cloaca was white, smooth and non-adhesive. Two semitransparent, gelatinous appendages extended forward from the spermatophore and securely held it in place. These appendages adhered readily to the forceps. They were evidently homologous to the gelatinous base of the first spermatophores described. One of the males collected the same day had a spermatophore adhering by a very short gelatinous base to the side of its tail (Fig. 1*c*) in the cloacal region. In view of our observations made the previous June it would seem that the female had rubbed a stalked spermatophore into her cloaca and that this had been held in place by parts of the stalk which adhered to the cloacal lips Similarly, the male may have accidentally picked up a spermatophore with its tail after the spermatophore had been deposited. These November observations, if taken alone, would not exclude the possibility that spermatophores on very short stalks may be transmitted directly to the cloaca of the female. In either case it is important to emphasize that it is not the whitish material which adheres but some of the stalk substance. In addition to the above material we have available a number of preserved specimens. One female collected at Coytesville, N. J., March 31,1928, has a large spermatophore head in the posterior part of her cloaca. As the spermatophore head was not soiled it would seem probable that it had been only recently deposited.

On January 6, 1928, a day following a week of cold weather, an adult female *Desmognathus phoca* was found moving over the wet rocks, in a terrarium in the American Museum, with a spermatophore held within the lips of the cloaca. The spermatophore almost filled the orifice and was held in place by shreds of gelatinous substance. The latter were not clearly marked off from the whitish material, some of which seemed to be adhesive, apparently due to a thin ventral covering of gelatinous substance. When the spermatophore was lifted from the cloaca the whole dorsal third was found to be a solid mass of spermatozoa, grayish white in color, and scarcely mixed at all with the underlying whiter material (Fig. 2*c*). In this character the spermatophore differed from that of *D. f. fuscus*. No other spermatophores were found in this terrarium although the species bred there successfully later in the season.

During October and November, 1928, we collected large numbers of *Eurycea bislineata* at Leonia, N. J., and Yonkers, N. Y. On October 25, two females were found in Leonia with spermatophores within the cloacal lips. On October 28, two additional females with spermatophores were found in the same place. On November 11, two more females with spermatophores were found in Yonkers, and on November 25 another female with spermatophore in the cloaca was collected at

Englewood, N. J. All seven spermatophores were located in the posterior half or third of the cloacal orifice and in no case was the outlet of the alimentary tract materially obstructed by the spermatophore. The three spermatophores collected in November were distinctly smaller than the October material but the sperm they contained was found under the microscope to be active. The bulk of each spermatophore was composed of the whitish substance and the part which protruded slightly from the cloaca was stained, apparently due to dirt which adhered to the more gelatinous part of the spermatophore. The sperm-cap and the outwardly directed gelatinous material were found under the binocular to be not sharply demarcated one from the other. On December 15 the remnants of a spermatophore were found within the posterior part of the cloaca of a female collected in Yonkers. On January 20, 1929, the remnants of two additional spermatophores were found in two females collected at Closter, N. J. On February 17, 1929, four out of five adult females of *E. bislineata* collected at Leonia, N. J., contained remnants of spermatophores in their cloacas. The above series demonstrates that spermatophores are carried within the posterior part of the cloaca of *E. bislineata* from late October to at least mid-February, and further, that the spermatophores gradually dwindle away. How much time is required for a single spermatophore to be absorbed, if indeed they are absorbed, can not be determined from the present data.

Blanchard (1928), over a three-year period, found no less than ten females of *Plethodon cinereus* with spermatophores. As in the case of *Eurycea bislineata* these were in the posterior part of the cloaca but Blanchard's description of them as mere bags filled with sperm is completely at variance with the account given above of the spermatophores of other plethodontids. On November 4, 1928, we collected a female of *P. cinereus* at Yonkers, N. Y., with a spermatophore within its cloaca. This completely filled the space posterior to the dorsal prominence or pseudo-clitoris. Unlike the spermatophores of *Eurycea bislineata* it was completely enclosed by the cloacal lips and only visible when these were opened with the forceps. Nevertheless, a gelatinous base was attached to the spherical whitish mass and extended forward to attach to the anterior corner of the cloaca. Blanchard did not describe such a reduced stalk or base in his specimens and concluded "that the spermatophores are directly transferred." From our observations on the spermatophores of *Desmognathus fuscus* it would seem equally possible that *Plethodon*, as well as the other plethodontids discussed above, deposits stalked spermatophores on the ground. The head and part of the base of the spermatophore is later squeezed off by the cloaca of the female which we may assume would move over it in much the same way as has been described for several other species of salamanders. This suggestion is rendered the more probable in view of the observations of Bedriaga (1897) who found that the terrestrial *Hydromantes* deposits spermatophores on the ground. We may conclude that although the process of impregnation is not completely known for any plethodontid the available evidence favors the view that all plethodontids deposit stalked spermatophores. Each of those which is favorably placed is later squeezed in two and the sperm bearing part engulfed by the cloaca of the female.

The Plethodontidæ have been derived from the Salamandridæ and presumably from mountain-brook species. One might expect that the process of impregnation in the family would agree with that of the mountain-brook salamandrids. Bedriaga (1897) pointed out that in *Euproctus* the spermatophore consists of a gelatinous base and a sperm-bearing head The former, which adheres readily to objects, is described as being left behind when the female takes up the sperm-bearing part. Despax (1923) has presented evidence to show that in *E. asper* after the spermatophore has been deposited in the vicinity of the female's cloaca the spermatozoa are removed by the hind feet of the male and rubbed into her cloaca. But Dähne (1926) found that the spermatophore was placed in the cloaca of the female by the male with his hind feet, no intermediate stage of deposition occurring. This is more in agreement with the process in the other two species of the genus. *E. montanus*, according to Bedriaga (1897), transmits the spermatophore either directly from the cloaca of the male to that of the female or the spermatophore head is pushed into its final position by the upturned feet of the male. Bedriaga (1897) also reports direct transmission of the spermatophore in *E. platycephalus*. The direct method of impregnation characterizes at least some of these mountain-brook species and may be described as an adaptation to life in a current which would hinder the indirect process practiced by pond-dwelling salamandrids. Why, then, should we not expect the mountain-brook plethodontids to use the same methods of impregnation? There seem to be at least two reasons. First, brook plethodontids lack the prehensile tail of *Euproctus*. Secondly, to judge from our experiments in keeping *E. asper*, *E. platycephalus*, as well as several species of Plethodontidæ in similar tanks of loose stones and running water, most plethodontids (except the thoroughly aquatic *Leurognathus*, *Gyrinophilus danielsi*, *Pseudotriton rubra*, etc.) are more terrestrial during the breeding season than *Euproctus*. The most terrestrial salamandrids and plethodontids practice the indirect method and there is no good evidence that the direct method once learned in streams was ever passed on to the more terrestrial derived stocks.

Bedriaga (1897) stressed the functional differences in the two parts of the spermatophores which he described. The structure of the spermatophore of *Desmognathus* may be readily understood by examining the cloaca of the male. Squeezing the pelvic region will induce a flow from the three sets of glands within the cloaca. The pelvic glands which occupy the roof and part of the upper portion of the sides of the cloaca produce a creamy white secretion which will be readily recognized as the material which forms the bulk of the head of the spermatophore. The cloacal glands which have the greater number of their outlets perforating the villosities on either side of the cloaca produce a viscid transparent mucus which forms the stalk or area of attachment of the spermatophore. The abdominal glands which lie in the posterior angle of the male cloaca do not seem to take part in the formation of the spermatophore, or at least their secretion which is less viscid can not be recognized in the completed structure. The spermatozoa on reaching the cloaca mix with the pelvic gland material and this is ejected with a sticky base of cloacal gland secretion. All plethodontids have cloacal glands and hence we assume that their spermatophores are equipped with gelatinous stalks whether or not these be long or short.

We noticed from our binocular examination that the degree of mixing of the sperm and pelvic gland secretion varied from species to species. This variation is well shown in our sections of the spermatophores, figure 2 (*b*, *c*, *e*). It will be noticed that the spermatozoa form a cap and a central core to the spermatophore head found in the cloaca of the female *Desmognathus phoca* (Fig. 2*c*). In *Desmognathus fuscus* (Fig. 2*b*) and particularly in *Plethodon cinereus* (Fig. 2*e*) the sperm are more evenly distributed through the pelvic gland material. The spermatophore of the latter species is in no sense a bag as Blanchard concluded from a study of the external appearance, but, as shown in the sections, consists of a mass of sperm and pelvic gland secretion well mixed.

Wilder (1913) has made a study in *Desmognathus f. fuscus* of the spermatozoa from both the spermatophore and from the vas deferens. She states:

> I have invariably noted a certain appearance of which I have as yet found no mention in the literature upon the subject. [When the spermatozoa uncoil] there is gradually revealed an elongated or oval mass (*cor*), apparently of semifluid consistency and of translucent material which seems to form the core about which the coiling

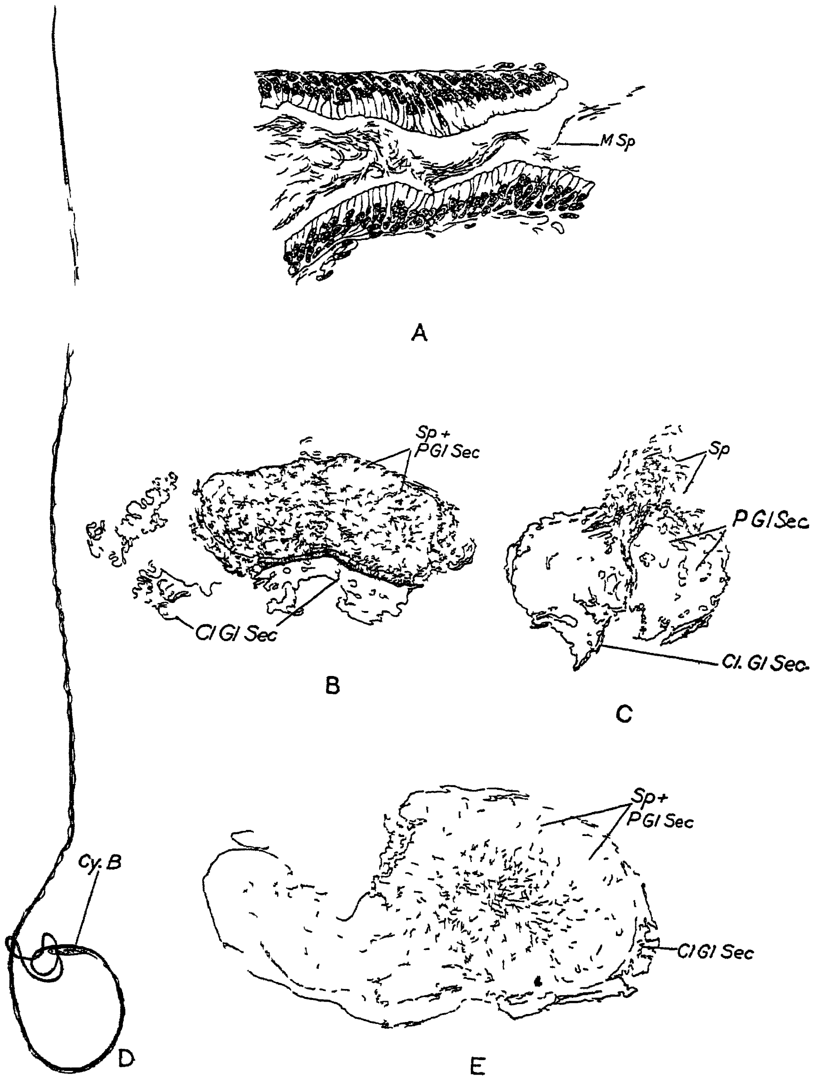

Fig. 2. Plethodontid spermatophores, spermatozoa and spermatheca.

(*a*) A portion of the common duct of a spermatheca of *Eurycea bislineata*, showing the hypertrophy of the cells forming the epithelium The cloaca is on the right ×250.
(*b*) Spermatophore of *Desmognathus fuscus*, cross-section × 58.
(*c*) Spermatophore of *Desmognathus phoca*, cross-section ×58
(*d*) Spermatozoan of *Desmognathus phoca* ×848
(*e*) Spermatophore of *Plethodon cinereus*, cross-section ×58

Cl. Gl. Sec. =Secretion product of cloacal glands.
Cy. B =Cytoplasmic body.
M. Sp =Migrating spermatozoa.
P. Gl. Sec. =Secretion product of pelvic glands
Sp =Spermatozoa

takes place and which is enclosed in the last final loop of the tail as it uncoils. As spermatozoa within the tubules of the testis do not possess this structure, it is apparently acquired in the passage from the testis into the duct and is very likely a secretion of mucous nature derived from certain specialized cells. Its nature and source, however, as well as its function, require further investigation. If it is peculiar to *Desmognathus* it may well be an adaptation to the prolonged period which must often elapse between the introduction of the spermatozoa into the spermathecæ of the female and the actual fertilization of the eggs, and is one of the many devices which it is necessary for a terrestrial form to develop to resist the drying action of the air.

We have examined sperm from the vas deferens of *Desmognathus fuscus fuscus, D. f. carolinensis, D. phoca, D. quadra-maculatus, Leurognathus marmorata intermedia, Eurycea bislineata* and *Plethodon cinereus.* Our material was in the form of smears, some fixed in Zenker's, others in Bouin's, and others in osmic vapor. In all species the cytoplasmic body described by Wilder was plainly visible although it was not present in all spermatozoa and obviously because it may be easily detached. Thus, the body is not characteristic of terrestrial species, for it is equally well developed in aquatic forms. The structure is no doubt the same as that described some years previously by Ballowitz (1906) in the European plethodontid, *Hydromantes italicus.* He noted that the body was easily destroyed by salt solutions. The cytoplasmic body, therefore, is a characteristic of the Plethodontidæ (so far as known) and not restricted to certain species having special habits.

The cytoplasmic body seems to us to be merely a part of the cytoplasm which in most Amphibia is thrown off at the time the tail membrane is formed. Such temporary globules of cytoplasm have been regularly found in the immature sperm of Salientia (Broman, 1900, 1907; Ballowitz, 1905; Retzius, 1906). Retzius (1906) described them in the young sperm of *Salamandra maculosa* and McGregor (1899) records the persistence of such a cytoplasmic body on the tail of the mature sperm of *Amphiuma.* McGregor finds that this body is broken off during the active movements of the spermatozoan. Only in the Plethodontidæ does the cytoplasmic body remain as an apparently useless vestige of a previous stage of development carried by most sperm until at least the time of impregnation.

The spermatozoa of the Plethodontidæ mature in the testes and Wilder was mistaken in claiming that the cytoplasmic body does not occur in sperm obtained from these organs. We have found the cytoplasmic body fully formed and attached to the tail of spermatozoa from the testes of *Desmognathus fuscus fuscus, D. f. carolinensis, D. quadra-maculatus* and *Plethodon cinereus.* Many spermatozoa from the testes lack cytoplasmic bodies but this is also true of spermatozoa from the vas deferens. The cytoplasmic bodies are easily broken off, for many detached bodies are seen in the smear preparations.

Wilder (1913) has figured the spermatozoan of *Desmognathus f. fuscus* but has discussed very little of its structure other than that of the cytoplasmic body. Wilder does not indicate an acrosome which is clearly differentiated in all the plethodontids described above. Under the highest powers it may be seen that the tip is bent back at an acute angle forming a barb such as Retzius (1906) figured in *Hydromantes italicus.* The barb is clearly visible only when seen in profile. We have figured a spermatozoan of *Desmognathus phoca* (Fig. 2*d*). It differs slightly in size and proportions from the spermatozoa of other species of *Desmognathus.* In *D. f. fuscus* as well as in the other species of the genus the middle piece is proportionately longer than Wilder figured. The spermatozoa of the urodeles unlike those of the Salientia are singularly uniform. It is possible that the differences in relative length of acrosome, head and middle piece found in the Plethodontidæ may have some systematic value but our series is not sufficiently extensive to draw any conclusions at this time.

There are several questions concerning the impregnation of the female salamander which have not been adequately considered in any species. How do the spermatozoa find their way into the spermatheca? What happens to the remnant of the spermatophore after the spermatozoa have left it? We have attempted to answer these questions by studying sagittal sections of the cloacas of two females of *Eurycea bislineata* with the spermatophore *in situ* and sections of one other with only a remnant of the spermatophore remaining. In regard to the first question Wilder (1923) implies that in *Desmognathus* the spermatophores in the air would undergo drying "and thus become sufficiently compact to be stored in the spermatheca." There is no evidence from our *Desmognathus* material that the spermatophores do undergo drying, while our sections of the cloacas of *Eurycea* reveal that the process of filling the spermatheca is one of migration of individual spermatozoa. This is clearly shown in one of the females collected October 25. Spermatozoa are distributed either singly or in small groups extending from the disintegrating spermatophore (Fig. 3) to the common duct of the spermatheca. It is remarkable that although spermatozoa are abundant posterior to the opening of the common duct into the cloaca not a single one is found in our sections anterior to this point. No spermatozoa are found in the large intestine or oviducts although their openings into the cloaca

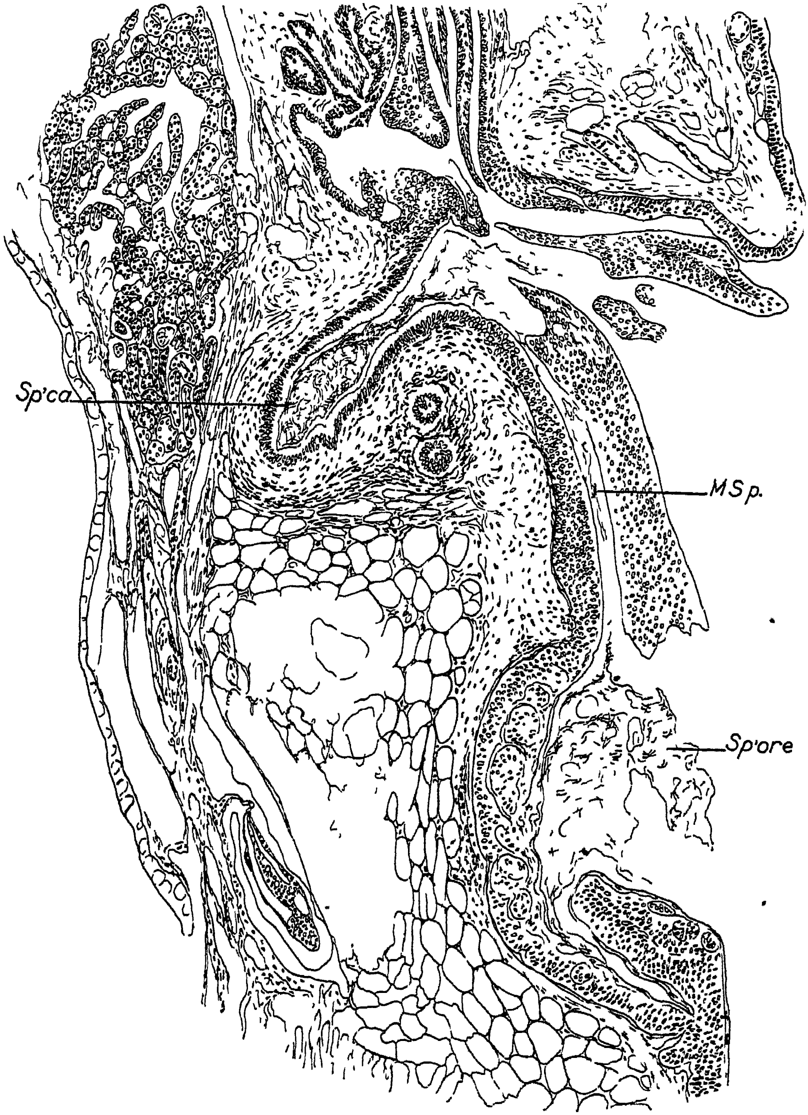

Fig. 3. Sagittal section of the cloacal region of the female *Eurycea bislineata*, showing the spermatophore within the cloacal lips and the migration of spermatozoa to the spermatheca. ×44.

M. Sp. = Migrating spermatozoa.
Sp'ca. = Spermatheca filled with spermatozoa.
Sp'ore = Spermatophore.

would seem available to spermatozoa migrating along the dorsal surfaces of the latter structure. It is apparent that the spermatheca does not act as a catch-basin trapping the spermatozoa which happen to enter its common duct. Rather it would seem to function as a source of attraction, for otherwise spermatozoa would be found widely distributed about the voluminous cloaca.

An examination of the structure of the epithelium of the cloacal region strongly suggests that the source of attraction is a secretion released from the epithelium of the spermatheca and particularly from its common duct. The epithelium of this duct is hypertrophied, its cells tall and columnar (Fig. 2*a*). In slides fixed in Zenker's and stained in Mallory's, the distal half of the cells stain pale blue similar to the mucus of the mucous glands in the integument. The same region stains feebly in eosin. Aside from the glands, only the spermatheca and the cloacal epithelium immediately surrounding its common duct exhibit this hypertrophied form. No cilia are found in the common duct nor on the cloacal epithelium. We have made a study of the epithelium directly underlying migrating spermatozoa and have found no cilia which could be propelling them. Nevertheless, numbers of spermatozoa may be seen directed toward the small opening (Fig. 3) of the common duct. It thus seems that the response must be chemotropic to secretions released by the spermatheca.

Unfortunately, we have not been able to examine sections of the cloaca of the female *E. bislineata* taken at different times of the year. But the cloaca of a *Desmognathus fuscus* killed in March exhibits no hypertrophy of the epithelium of the common duct of the spermatheca, although the spermathecal tubules are filled with sperm.

It will be noted from figure 3 that the spermatozoa migrate a considerable distance from the spermatophore before finding the small entrance to the spermatheca. How are they released from the spermatophore head? Does the mucous surface alone permit them to free themselves from the pelvic gland secretion which binds them together? An examination of the sections of the posterior part of the cloaca of the specimen of *Eurycea bislineata* discussed above has revealed a remarkable modification of the epithelium not found anywhere else in the cloaca. The epithelium is vacuolated by clusters of polymorphonuclear leucocytes (Fig. 4). Some of these vacuoles break through to the outside, thus forming crypts. At several points the leucocytes may be noted in the act of leaving the crypt and entering the spermatophore. Although numbers of mononuclear and polymorphonuclear leucocytes cover the dorsal and

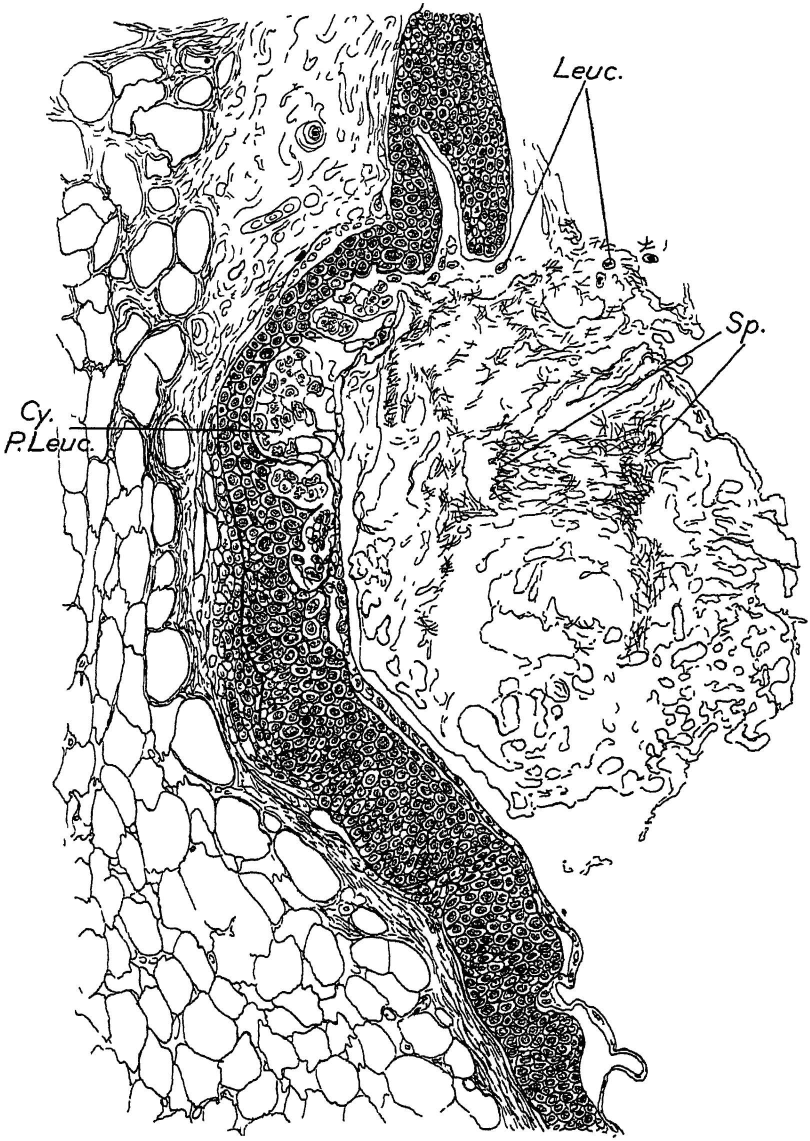

Fig. 4. Spermatophore of *Eurycea bislineata, in situ,* within the cloacal lips of the female. Polymorphonuclear leucocytes have formed cysts within the epithelium of the cloacal lips and other leucocytes are phagocytosing the spermatophore. ×122.

Cy. P. Leuc. = Cysts of polymorphonuclear leucocytes.
Leuc. = Leucocytes.
Sp. = Spermatozoa.

anterior portions of the spermatophore, they have not penetrated to any depth into the mass. Many of the polymorphonuclear leucocytes show eosinophilic or basophilic granules. No capillaries are found in the cloacal epithelium. It would seem that the leucocytes had invaded the epithelium to phagocytose the overlying spermatophore, and that disintegration of the spermatophore is hastened by this action.

This interpretation is supported by the structure of the cloacas of the other two spermatophore-bearing females of *Eurycea bislineata* sectioned. Cysts of polymorphonuclear leucocytes are found only in the cloacal epithelium immediately underlying the spermatophores. That they have nothing to do with the shedding of the surface layers of this epithelium is obvious from the specimen collected October 28, which shows that the superficial layer of the epithelium alone is shed. Both specimens have the spermathecas crammed with spermatozoa and apparently represent the last stages in the process of migration. In the December specimen there is a small residue of spermatozoa and cell débris in the posterior part of the cloaca. Only a few leucocyte vacuoles are present and only one of these is open to the outside. There are a few spermatozoa in the cloaca immediately anterior to the opening of the spermathecal duct but none elsewhere in the cloaca. The specimen collected October 28 has a quantity of pelvic gland secretion and of cell débris in the posterior part of the cloaca. Polymorphonuclear leucocyte vacuoles are smaller and less numerous than in the other October specimen. No spermatozoa are in the cloaca but a few are migrating singly up the common duct of the spermatheca. It is interesting that these two specimens should differ so greatly in amount of spermatozoa and pelvic gland secretion remaining after the spermatheca was filled. Perhaps the proportions of these two ingredients of the spermatophore head differed originally in the two individuals. It is further difficult to explain why the leucocytic infiltration of the cloacal epithelium should be so much greater in the specimen with the migration of the spermatozoa at its height. It would be interesting to know whether a similar migration of spermatozoa and a phagocytosis of the spermatophore head occurs in other families of salamanders.

SUMMARY

(1) *Desmognathus f. fuscus* deposited stalked spermatophores on leaves out of water in June.

(2) The head and part of the stalk of the spermatophore were found in the cloaca of the female *Desmognathus f. fuscus* in October and November, and also in late March.

(3) The same parts of a spermatophore were found in the cloaca of a female *Desmognathus phoca* confined in a terrarium in January.

(4) The same parts were found in the cloacas of a series of female *Eurycea b. bislineata* collected from October 25 to February 17.

(5) It is suggested that all plethodontids deposit stalked spermatophores and that the females remove the head and part of the stalk with their cloacal lips.

(6) The spermatophore of *Plethodon cinereus* is not a sac of sperm but agrees so far as known with that of other plethodontids.

(7) The cytoplasmic body of the spermatozoan is a characteristic of the Plethodontidæ and is not a terrestrial adaptation.

(8) The spermatheca is filled by a migration of individual sperm from the disintegrating head of the spermatophore while lodged in the posterior angle of the cloaca of the female.

(9) A secretion from the spermatheca, and especially from its common duct, guides the spermatozoa to the spermathecal tubules.

(10) The spermatophore head is phagocytosed by leucocytes which escape in numbers through that part of the cloacal epithelium underlying the spermatophore.

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AMERICAN MUSEUM NOVITATES

Number 352
Published by
The American Museum of Natural History
New York City
May 20, 1929

59.78(51.2)

FOUR NEW FROGS FROM FUKIEN PROVINCE, CHINA

Clifford H. Pope

In this paper I describe four new frogs collected by myself, in Fukien Province, for the Third Asiatic Expedition of The American Museum of Natural History, during 1925 and 1926.

Megalophrys kuatunensis, new species

Type.—A. M. N. H. No. 30126; adult ♂; Kuatun, Chungan Hsien, northwest Fukien Province, China; altitude 5500-6000 feet; April-September, 1926; Clifford H. Pope.

Diagnosis.—Closely allied to *boettgeri* of the same locality and *minor* of Szechwan. It differs from the former in the possession of a dark, thin, χ- shaped marking occupying the middle of the back, in being dull brick-red instead of blackish, and in having distinctly smaller toe webs. *M. boettgeri* is a slightly larger species. The tibia of the new species is less than half as long as the head and body, while that of *minor* is more than half this length. The tibio-tarsal articulation, when stretched forward in *kuatunensis*, reaches as far as the center of the eye or not so far, but in *minor* it extends beyond the eye.

Description of Type.—Tongue entire, vomerine teeth lacking. Head moderate, as broad as long; snout very short, obliquely truncate, strongly projecting beyond the mouth. Canthus rostralis angular, loreal region concave; interorbital space as broad as the upper eyelid; tympanum distinct, half the diameter of eye. Fingers slightly swollen at the ends, first and second equal. Toes slender, scarcely swollen at the tips, with barest rudiment of web; a small, oval, flat inner metatarsal tubercle; no subarticular tubercles. The tibio-tarsal articulation reaches to the center of the tympanum, while the tibia is two-fifths as long as the head and body. The skin is smooth. Length, from snout to vent, 32 mm.

The dorsum is brown, a little darker than the ventrum. There is a dark, χ-shaped marking on the back and another triangular one on the head, one point of which extends onto either upper lid. In addition to these, there are a few small spots on the back. The belly is boldly spotted with dark spots, the two largest of which are light-centered and occupy a lateral position on the middle region of the belly, the next pair in size being on either side of the throat. A conspicuous spot is found midway between the arm insertions. The lips are barred, especially the lower. The limbs are barred dorsally and, except the ventral side of the thighs, spotted below the bars. A dark band extends from the tibio-tarsal articulation onto the bottom of the foot. There is a white spot on the back of the thigh.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 87.

Notes on Paratypes.—The thirty-one paratypes come from the type locality (A. M. N. H. Nos. 30123–24 and 30230–58) and agree well with the type. Tadpoles were secured.

This species, though remarkably similar to *boettgeri* in body form, is easily distinguished by the X-shaped, dorsal marking, no trace of which is ever present in *boettgeri*. The type of *minor* is unique and shows no sign of a dorsal marking. I have omitted this point from the diagnosis because lack of such in *minor* may be the result of preservation.

The texture of the skin in *boettgeri* and *kuatunensis* is extremely variable, though the latter has the smoother skin in the majority of specimens.

These two species inhabit the same streams about Kuatun but *kuatunensis* is invariably found at higher altitudes. There is a marked difference in their calls.

Hyla sanchiangensis, new species

Type.—A. M. N. H. No. 30198; adult ♂; San Chiang, Chungan Hsien, northwest Fukien Province, China; 3000–3500 feet altitude; April–May, 1926; Clifford H. Pope.

Diagnosis.—A mountain form closely related to *chinensis* but differing conspicuously in coloration.

Description of Type.—Vomerine teeth two-thirds behind line joining anterior edges of choanæ, nearer to each other than to choanæ. Diameter of tympanum two-fifths that of eye; diameter of finger pads slightly greater than that of toe pads. Tibiotarsal articulation reaching center of eye. Fingers with small webs; toes two-thirds webbed. Skin smooth. Length, from snout to vent, 34 mm.

The back is purplish brown (leaf-green in life), the belly uniformly light. There are numerous black spots on the posterior sides, both sides of the upper legs, and the inside of the lower legs; also on the arms and around their bases. A fine black line starts at the tip of the snout, passes over the nostril, through the eye, immediately above the tympanum, and along the upper sides to join the first black spots of the posterior sides. A similar line beginning below the nostril skips the eye and skirts the tympanum, extending parallel to the first line as far as the base of the forearm where it meets the black spots of that region. In alcohol the color of the area between these two lines is not markedly different from the general color of the sides. The upper lips are weakly and irregularly bordered with black.

The type, taken during the breeding season, has conspicuous dark nuptial pads on the inner fingers and large grayish vocal sacs just anterior to the insertion of the foreleg.

Notes on Paratypes.—The twenty-nine paratypes (A. M. N. H. Nos. 30171–97 and 30199–200) come from the type locality and agree with the type in every essential. A series of tadpoles was also secured.

The conspicuous black markings of this species distinguish it at a glance from *arborea immaculata* of the Yangtze Valley, *simplex* of the extreme South, and Vogts' *albotæniata* of "South China." *H. annectans* of Yunnan possesses the strong tuberculated fold from the eye to the base of the upper arm of which no sign is present in the new species, while *bambusicola* (*monticola*) of Szechwan has many red-centered ocelli on the back. *H. chinensis* entirely lacks the black spots on the forearm as well as the fine parallel lines described above, and possesses a sharply differentiated reddish-brown (in alcohol) triangle outlined in black covering the tympanum and ending just above the base of the forearm.

Rana chunganensis, new species

TYPE.—A. M. N. H. No. 30479; adult ♂; Kuatun, northwest Chungan Hsien, Fukien Province, China; 4500–5000 feet altitude; August, 1926; Clifford H. Pope.

DIAGNOSIS.—A *Hylorana* with well-formed digital pads bearing distinct crescentric grooves separating the upper from the lower surfaces. The pads are not twice as broad as the narrowest part of the corresponding penultimate phalanx. There is a weakly developed dorso-lateral fold. Sexual dimorphism is extremely marked, the male being much smaller in size and lighter in dorsal coloration than the female. The male moreover possesses a pair of prominent external vocal sacs, a humeral gland, and a pad on the first finger.

DESCRIPTION OF TYPE.—Vomerine teeth in oblique series, their anterior edges on a line with centers of choanæ.

Head longer than broad, depressed; snout projecting beyond mouth, slightly longer than eye; canthus rostralis obtuse; loreal region feebly oblique, concave; nostril barely nearer tip of snout than eye; distance between nostrils equal to interorbital width; tympanum distinct, three-fifths diameter of eye, separated from eye by a distance equal to half diameter of tympanum.

Fingers long and slender, their tips bearing pads with distinct crescentric grooves separating the upper from the lower surface; first finger barely as long as second, a pad on its inner side. Subarticular tubercles well developed. Toes with pads similar in form and size to those of fingers; webbed to base of pads on all but longest toe where webbing reaches only to last subarticular tubercle; latter well developed as on fingers; outer metatarsals separated nearly to base. Inner metatarsal tubercle oval, feebly prominent, no outer tubercle.

Hind limb long and slender, tibio-tarsal articulation reaching to end of snout; heels strongly overlapping; tibia contained 1.7 times in length of head and body.

Dorso-lateral fold feeble, especially posteriorly; a glandular fold from below tympanum to shoulder. Skin smooth.

The color is reddish brown above but light beneath. The back is covered with dark speckles. A black stripe extends from the tip of the snout to the eye and from behind the eye to the base of the thigh. Posterior to the eye its upper border is the dorso-lateral fold. The stripe is widest from the eye to above the insertion of the forelimb, posterior to which it rapidly narrows. The tympanum is included in this stripe. A narrow white stripe extends from below the nostril to the shoulder. It passes just under the eye and tympanum. The limbs are barred dorsally.

There is a large, external vocal sac on each side extending from below the eye to the base of the forelimb and an oval gland on the inner arm.

The type measures 39 mm. from snout to vent.

Notes on Paratypes.—Ninety-two paratypes come from the type locality (Nos. 28832, 30139–41, 30395–478 and 30480–83), three from Yenping (Nos. 28419 and 30820–21). All the males agree well with the type. An adult female measures 58 mm. from snout to vent. A large series of tadpoles was secured.

This species seems to be related to *humeralis*, and *oatesii* of Burma, and *miopus* of Siam, which form a group in Boulenger's *Hylorana* key. It resembles these in the possession of the humeral gland but differs in the comparative length of the first two fingers as well as many minor points.

Rana fukienensis, new species

Type.—A. M. N. H. No. 29182; adult ♀; Futsing Hsien, northeastern Fukien Province, China; August–October, 1925; Clifford H. Pope.

Diagnosis.—A species combining the characters of *nigromaculata* and *plancyi*. Its relation to *plancyi* is shown through the white stripe along the back of the thighs so characteristic of that species, and the lack of an external vocal sac in the males, while in general habitus and coloration it strongly suggests *nigromaculata*.

Description of Type.—Vomerine teeth in two rounded groups between the choanæ, their distance from the latter about equal to the distance between them; nostrils distinctly nearer the tip of the snout than the eye; toes fully webbed; tips of digits tapering, rounded, not at all expanded or grooved; subarticular tubercles distinct but small; inner metatarsal tubercle medium, its length half that of the fifth toe; an indistinct outer tubercle, no tarsal fold; an inconspicuous dorso-lateral fold. The skin is generally smooth but in the posterior region of the back finely granular.

The color of the back in alcohol is grayish olive with a faint mid-dorsal longitudinal stripe from the tip of the snout to the vent. The ventrum is light with very faint gray mottling more distinct on the thighs. There are a few black spots on the posterior region of the back and irregular bars across the tibia. A distinct white band extends along the back of the thighs above which the thighs are boldly mottled. A black band starts at the base of the thigh and extends forward along the side. It breaks into spots before reaching the insertion of the arm but is continued as a band along the posterior side of the arm to the palm. There is another black line from the shoulder to the angle of the jaw.

The length of the tibia (39 mm.) is 0.54 that of the distance from the snout to the vent (72 mm.)

Notes on Paratypes.—There are fifteen paratypes from the type locality (A. M. N. H. Nos. 29183–89 and 29420–27), and four from Chungan Hsien (A. M. N. H. Nos. 28946–49), all collected in 1925. In addition, a juvenile paratype (A. M. N. H. No. 30001) was collected the following year in Chungan Hsien. The paratypes with one exception agree in every essential with the type. The American Museum contains a large series from Horisha, Formosa, previously identified as *plancyi*. They agree well with the new species except that their bellies are lighter and less mottled.

R. fukienensis seems to be intermediate between *plancyi* and *nigromaculata*. It may readily be told from *plancyi* by:

(1) Its much shorter and lower metatarsal tubercle. This tubercle is only one-half the length of the fifth toe, but in *plancyi* it is three-fourths this length. In *plancyi*

it is set at a distinct angle to the line of the first toe, while in *fukienensis* it is almost parallel. This difference is very constant.

(2) Its distinctly greater leg length. The length of the tibia in *plancyi* is contained two and one-third to two and a half times in the length from the snout to the vent, the tibio-tarsal articulation barely reaching the tympanum, while in *fukienensis* the tibia is one-half as long as the body and head, and the tibio-tarsal articulation reaches the center of the eye.

(3) The dorso-lateral ridges. In *plancyi* these are uniformly broad, low and often flaring; in *fukienensis* either narrow or broad, high or low, and nearly or perfectly parallel.

(4) Coloration. *R. plancyi* lacks the mid-dorsal stripe, which though often faint, is nearly always present in *fukienensis*. The thighs, above the light stripe possessed by both species, are much more boldly mottled in *fukienensis*, while *plancyi* has an immaculate belly contrasted with the more or less faintly mottled belly of mainland *fukienensis*.

It may be readily told from *nigromaculata* by:

(1) The smaller metatarsal tubercle which in *nigromaculata* rivals that of *plancyi* in size.

(2) The lack of glandular ridges between the dorso-lateral folds. These ridges are very conspicuous in *nigromaculata*. The juvenile specimen (No. 30001) forms the only exception among the large series of paratypes.

(3) The apparent lack of a well-developed external vocal sac. All of the larger paratypes are females and the general scarcity of males makes the confirmation of this point desirable.

(4) Coloration. The light stripe along the thighs so characteristic of *plancyi* and *fukienensis* is never found in *nigromaculata* which also seldom shows traces of the black lateral stripe very conspicuous in *fukienensis* and present at least posteriorly in *plancyi*.

In addition, there are minor differences of color, and certainly a comparative examination of living specimens would reveal still more striking contrasts.

AMERICAN MUSEUM NOVITATES

Number 353

Published by
The American Museum of Natural History
New York City

May 30, 1929

56.9,72E (1181:51.7)

EMBOLOTHERIUM, GEN. NOV., OF THE ULAN GOCHU, MONGOLIA[1] [2]

By Henry Fairfield Osborn

The Oligocene titanotheres discovered in the seasons of 1922 and 1923 were first described and figured in previous numbers of *Novitates* and are fully monographed in the appendix of the U. S. Geological Survey Monograph No. 55, "The Titanotheres of Ancient Wyoming, Dakota, and Nebraska," pp. 895–945 (now in press). They embrace genera and species discovered in three formations and life zones, as below. At the time it was thought that the Ardyn Obo formation (500 ft. in thickness, containing *Brontops gobiensis* and *Menodus mongoliensis* of supposed Lower Oligocene age) represented the close of the Titanotherium dynasty in Mongolia. Accordingly the succession of horizons given below (p. 2) was published in 1925-1927.

DISCOVERY OF TWO NEW FORMATIONS AND LIFE ZONES

The seasons of 1924 and 1925, however, closed with the discovery of two new and highly fossiliferous Oligocene formations on the Uliassutai-Sair Usu-Kalgan trail lying conformably above the Shara Murun formation; these formations were first described in field notes as *Upper Shara Murun*. The workings (Fig. 1, Sect. 4) at Ula Usu (1923–1925) yielded *Menodus mongoliensis* and *Brontops gobiensis* as of typical Oligocene age (Ardyn Obo formation); in August and September of the same year Granger notes at Ula Usu, in the formations "Shara Murun and Upper Shara Murun" titanotheres numbers 566 (hind foot), 569 (fore foot), 570 (fore foot), and 571 (front of skull), from "red beds" underlying the fossiliferous "gray beds" bearing titanotheres, also a titanotherium skeleton of *Dolichorhinus* type.

Titanotherium skeleton. Uncovered but not taken. *Dolichorhinus* type. The posterior portion of skull and jaws; the entire column back to the 8th caudal; the scapulæ. humeri, one femur and the pelvis, with all ribs of one side and several of the other side in the bank. Other parts evidently had been present but eroded

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[1] Preliminary popular description in *Natural History*, Vol. XXIX, No 1, 1929, pp 2-16

[2] Publications of the Asiatic Expeditions of The American Museum of Natural History Contribution No 88.

THREE SUCCESSIVE TITANOTHERE-BEARING FORMATIONS OF MONGOLIA

Formation	Estimated Thickness	Geographic Region	Life Zone	Probable or Estimated Age
	Feet			
Ardyn Obo	500	Uliassutai trail	Brontops gobiensis zone; Menodus mongoliensis	Lower Oligocene
Shara Murun	500	Uliassutai trail	Protitanotherium mongoliense zone; Dolichorhinus, Telmatherium, Manteoceras	Summit of Eocene. Titanothere very abundant
Irdin Manha	40–100	Iren Dabasu basin	Protitanotherium grangeri zone; Dolichorhinus [illegible]keni, Telmatherium berkeyi.	Upper Eocene. Titanotheres presen

away. Bone very soft; vertebral centra rather badly flattened. No teeth. Found by Dr. Loucks in red clays west of camp at Ula Usu—1 mile. August 15th. 5×7 photograph taken. Vertebral formula: 7:17·4:3:8+.

[Field No.] 573 Miscell. Mammals. From various points along the northeastern face of the Ula Usu peneplane—mostly from two pockets four and eight miles north of Baron Sog Lamasery. August 16—Party. As far as possible only such bones as come from the lower gray beds (true Shara Murun) are recorded under this number.

[Field No.] 574 Artiodactyl. Upper teeth and foot bones. Aug. 18—Olsen. From Upper Red beds [=Ulan Gochu formation].

[Field No.] 575 Miscell. Mammals etc. From an upper horizon exposed along the eastern face of the peneplane from the Baron Sog Lamasery northward for 4 miles [Baron Sog beds]. Probably Oligocene (light gray beds). August—Party.

From the above citations, to be compared with figures 1 and 2 and Granger's "Record of Fossils, Mongolia, 1925," pp. 43–66, it appears that Granger in 1925 discovered and clearly demarcated *two new and rich faunal horizons* without naming them, i.e., the *Baron Sog* and the *Ulan Gochu*. He also recognized as a new form of titanothere the anterior portion of a cranium (Field No. 595, Amer. Mus. 21610—Figs. 9, 10), discovered in the base of the "upper red beds," four miles north of Baron Sog, to which in the present *Novitates* is assigned the name *Embolotherium loucksii*, in honor of Dr. Harold Loucks, the discoverer of this unique specimen. This bears the inscription (Granger's "Record of Fossils, Mongolia, 1925," p. 56):

[Field No.] 595 Horned Perissodactyl. Portion of skull with horn and last molar tooth of right side. From base of Upper Red Beds [=Ulan Gochu] 4 miles north of Baron Sog Lamasery. Sept. 2—Granger. Found by Loucks. [=*Embolotherium loucksii*.]

These two new faunal horizons are:

Baron Sog Formation (Granger, 1925, 1928). Estimated thickness 35 feet, containing numerous new and undescribed baluchitheres—Field Nos. 731, 732, 744, 745, 753, 773, and 780, also undescribed entelodonts, lophiodonts, rhinocerotids, chalicotheres, etc. No record of titanotheres or embolotheres.

Ulan Gochu Formation (Granger, 1925, 1928). Estimated thickness min. 132 feet, max. 195 feet; containing embolotheres—Field Nos. 595 (type of *Embolotherium loucksii*), 750 (type of *Embolotherium andrewsi*), 735 (*Embolotherium andrewsi* ref.), 708 (*Embolotherium andrewsi* ref.), 770 (type of *Embolotherium grangeri*), 756 (*Embolotherium grangeri* ref.), and 673 (*Embolotherium grangeri* ref.); also numerous undescribed embolotheres—Field Nos. 740, 741, 742, 746, 751, 755, and 782, as well as undescribed lophiodonts, rhinocerotids, artiodactyls, and carnivores. No baluchitheres thus far certainly recorded.

A *sharp unconformity* (Fig. 2, Sects. 1, 2, 3) between the Ulan Gochu (oblique shading) and the overlying Baron Sog indicates that a long interval in geologic time elapsed between these two formations.

During this interval may possibly have occurred to the east (Houldjin) and to the northwest (Hsanda Gol) the deposition (3,000 ft.) of the Hsanda Gol and (30 ft.) of the Houldjin (Baluchitherium grangeri zone), because both Andrews and Granger believe that the undescribed *Baluchitherium* sp. of the Baron Sog formation belongs to a specific and perhaps generic stage more advanced than *Baluchitherium grangeri.*

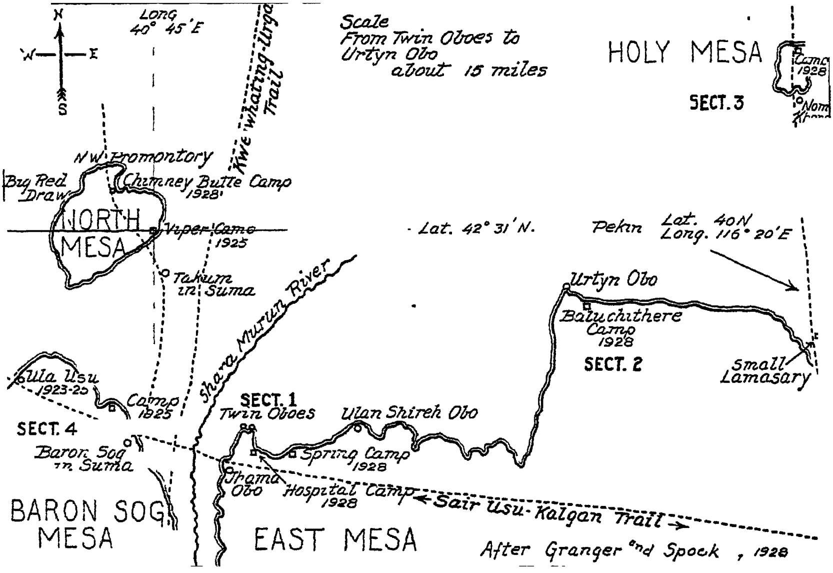

Fig. 1. Sketch map by Granger and Spock (1928) along the Sair Usu-Kalgan trail, 15 miles east and west, displaying exposures of typical Shara Murun, and 'upper Shara Murun' or the new 'Ulan Gochu' and 'Baron Sog' formations explored by the American Museum parties of the years 1924-1925 and 1928. After sketch by Walter Granger.

From the summit of the Ulan Gochu downward there are no apparent breaks. Granger writes (letter, Peking, December 31, 1928):

> You will notice from these sections [Fig. 2] that we have no sharp line between the Ulan Gochu beds and the Shara Murun. The geologists have not been able to discover any stratigraphic break between the top and the base of these Eocene sediments of the Shara Murun region and we have set off the 'Ulan Gochu beds' from the 'Shara Murun' on the basis of faunal change only. I have used the name, 'Ulan Gochu,' to cover such strata as contain the new type of titanothere [*Embolotherium lovcksii*], and certain advanced artiodactyls which do not occur in the typical Shara Murun of Ula Usu. The whole fauna of these Ulan Gochu beds will probably show a

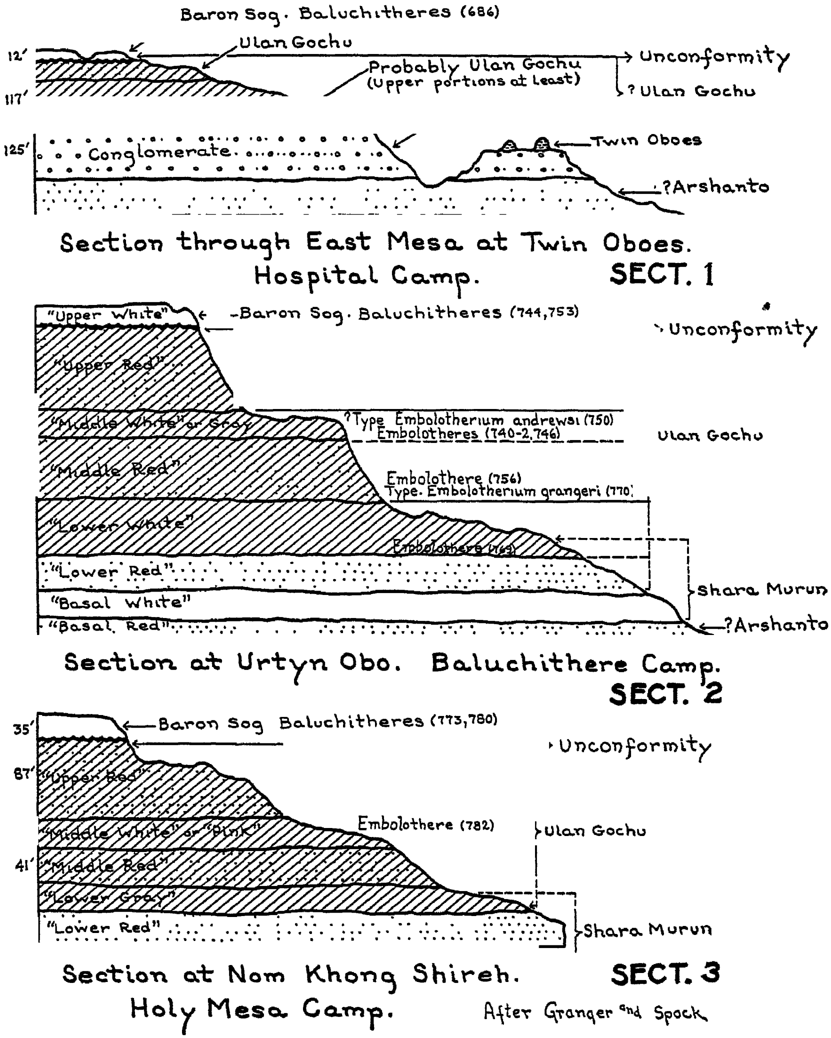

Fig. 2. Sections through the Shara Murun, Ulan Gochu, and Baron Sog formations at the points indicated in figure 1. After sketch by Walter Granger. Theoretic limits of the 'Ulan Gochu' formation, Embolotherium zone, in oblique shading.

Sect. 1. Through East Mesa at Twin Oboes, Hospital Camp (1928).

Sect. 2. At Urtyn Obo, Baluchithere Camp (1928), type locality of *Embolotherium andrewsi* and of *E. grangeri*.

Sect. 3. At Nom Khong Shireh, Holy Mesa Camp (1928).

There is a sharp *unconformity* and erosional interval between the *Ulan Gochu* and overlying *Baron Sog*. The *Ulan Gochu* passes insensibly below into the *Shara Murun*.

distinct advance over that of the Shara Murun beds but I have just used these two as guide fossils. One titanothere skull from the Ulan Gochu beds (No. 742) is not of the *Embolotherium* type but is much like your *Brontops gobiensis* from the Ardyn Obo beds and I have been wondering if we do not have in the Shara Murun region sediments a transition, without break, from the Eocene to the Oligocene.

The discovery of these two new formations reveals a survival of the titanotheres in Mongolia, after their extinction in America, and renders probable a new theoretic sequence of life zones as below (p. 7).

THE ULAN GOCHU OR EMBOLOTHERIUM LIFE ZONE

The present *Novitates* is based upon eight specimens only, referable to three very distinct species of *Embolotherium*. Other specimens when received may reveal relationships to *Brontops gobiensis* or to other Lower Oligocene titanotheres such as *Menodus*. The characterizations are in a high degree preliminary.

As shown in Fig. 2, Sect. 2, at Urtyn Obo, the levels are divided as follows:

95′ "Upper Red." *Embolotherium* No. 673. (Base of: *Embolotherium loucksii* type.)

30′ "Middle White" or "Gray," or "Pink." *Embolotherium andrewsi* type (No. 750), *E. andrewsi* ref. (No. 708), also *Embolotherium* (Nos. 740–742, 746).

70′ "Middle Red." *Embolotherium grangeri* type (No. 770), also *Embolotherium* (No. 756).

65′ "Lower White." *Embolotherium* (No. 683).

The levels of all the *Embolotherium* and other titanothere remains have been carefully recorded and the vertical succession and evolution of the species will doubtless become evident and clear when the entire collection can be examined. Some of the specimens labeled "Titanothere" may prove to belong to other genera than *Embolotherium*.

All the remaining embolothere specimens, besides the eight herein described, have been prepared in the laboratory at Peking and are now on their way to the American Museum. We had hoped to receive these fossils in order to make the preliminary description more complete, but the long delay has compelled the writer to base his present description and figures on the materials in hand and on photographs and data relating to the specimens in Peking, kindly forwarded by Mr. Granger.

Fig. 3. Comparison of type crania.

Fig. 4. *Embolotherium andrewsi* type (Amer. Mus. 26001). After original.

Fig. 5. *Embolotherium andrewsi* ref. After photograph.

Fig. 6. *Embolotherium andrewsi* ref. Skull presented to the Chinese Geological Survey Museum.

NEW THEORETIC SEQUENCE (1929) OF MIDDLE OLIGOCENE TO UPPER EOCENE FORMATIONS

Formation	Estimated Thickness	Geographic Region	Life Zone	Probable or Estimated Age
	Feet			
Baron Sog	35	Uliassutai trail	Baluchitherium n. sp.	Lower and Middle Oligocene
Hsanda Gol	3,000	Eastern Altai	Baluchitherium grangeri zone	Lower and Middle Oligocene
Houldjin	30	Iren Dabasu basin	Baluchitherium grangeri? zone	Lower and Middle Oligocene
Ulan Gochu	Min. 132 Max. 195	Uliassutai trail	Embolotherium andrewsi zone; E. loucksii, E. grangeri	Extinction of titanotheres
Ardyn Obo	500	Uliassutai trail	Brontops gobiensis zone; Menodus mongoliensis	Lower Oligocene
Shara Murun	500	Uliassutai trail	Protitanotherium mongoliense zone; Dolichorhinus, Telmatherium, Manteoceras	Summit of Eocene. Titanotheres very abundant
Irdin Manha	40–100	Iren Dabasu basin	Protitanotherium grangeri zone; Dolichorhinus olseni, Telmatherium berkeyi	Upper Eocene. Titanotheres present

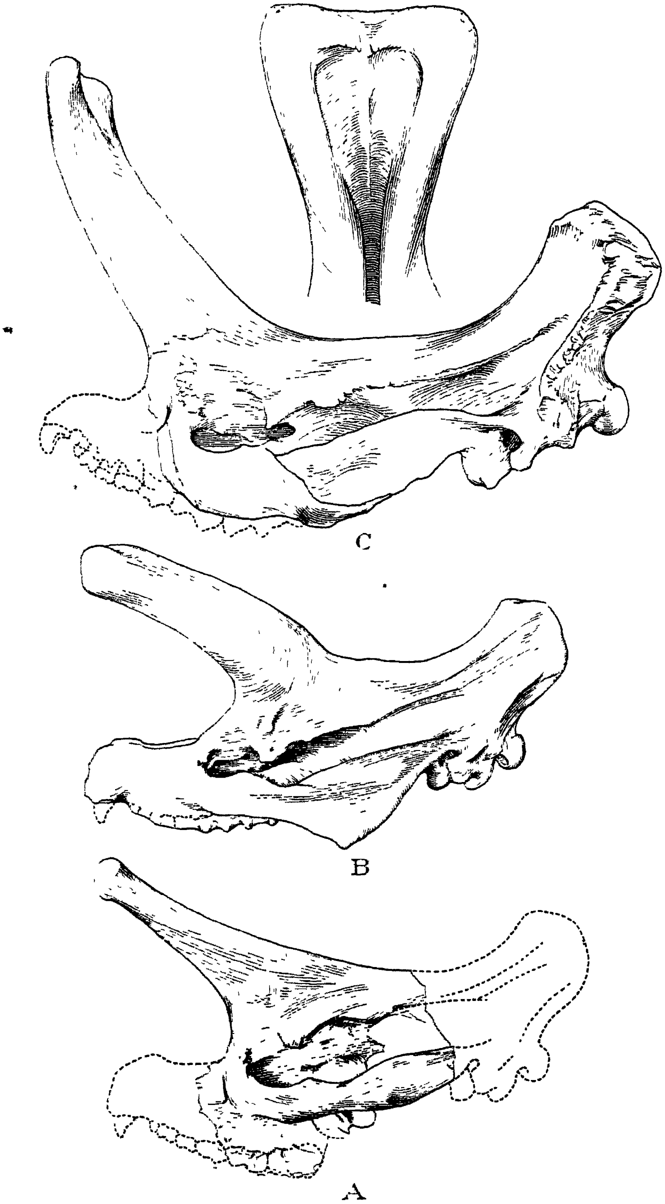

Fig. 3. Comparison of type crania of:
C, *Embolotherium andrewsi* type (Amer. Mus. 26001, Field No. 750).
B, *Embolotherium grangeri* type (Amer. Mus. 26002, Field No. 770).
A, *Embolotherium loucksii* type (Amer. Mus. 21610, Field No. 595).
One-tenth natural size

Fig. 7. *Embolotherium grangeri* type (Amer. Mus. 26002). After photograph of cranium from Peking laboratory. *Embolotherium grangeri* ref. After photograph from Peking laboratory.

Fig. 8. *Embolotherium grangeri* ref. After photograph from Peking laboratory.

Fig. 9. *Embolotherium loucksii* type (Amer. Mus. 21610). After original.

Fig. 10. Photographic view of same.

EMBOLOTHERIINÆ, subfam. nov.

One of the most surprising results of the Fifth Central Asiatic Expedition of the season of 1928, under the leadership of Roy Chapman Andrews and Walter Granger, was the discovery of an entirely new type of titanothere.

The subfamily Embolotheriinæ, typified by the characters observed in three distinct species of *Embolotherium*, probably represents a purely Asiatic phylum, no members of which have thus far been discovered in North America; nor do the three species of *Embolotherium* herewith described from the Ulan Gochu formation seem to be related to the titanotheres discovered in the three older geologic formations previously described; they appear rather to represent immigrants into the central Gobi region, whose ancestors lived farther north in central Asia.

In all, at least fourteen individual specimens of *Embolotherium* were found in the Ulan Gochu formation associated with the remains of lagomorphs and other rodents, carnivores, creodonts, hyænodonts, rhinocerotids, lophiodonts, and entelodonts characteristic of Lower to Middle Oligocene age. As shown in three sections (north of the bluffs on the Sair Usu-Kalgan trail, lat. 42° 31′ N.) prepared by Granger and Spock (Fig. 2), the Ulan Gochu formation has a thickness of 132 feet at Twin Oboes, 195 feet at Urtyn Obo, and 190 feet at Holy Mesa, thus representing a long period of geologic time.

EMBOLOTHERIUM, gen. nov.

Genotypic species *Embolotherium andrewsi*, sp. nov.

GENERIC CHARACTERS.—Premaxillaries elongate (*Embolotherium grangeri*), reduced (*E. andrewsi*); elevated anterior bony protuberances or nasal horns expanded at the summits, moderately broad (*E. loucksii*), extremely broad (*E. andrewsi*); frontals normal not entering into nasal protuberances. Broad postorbital expansion of vertex; zygomata extremely broad. Premolars with prominent tetartocones and partly separate metalophs; M 3 with prominent hypocone (*E. andrewsi*).

The generic name *Embolotherium* is given in reference to the unique structure of the forward portion of the cranium. The name is derived from the Greek ἐμβολή, "battering ram." As the 'brontothere' used

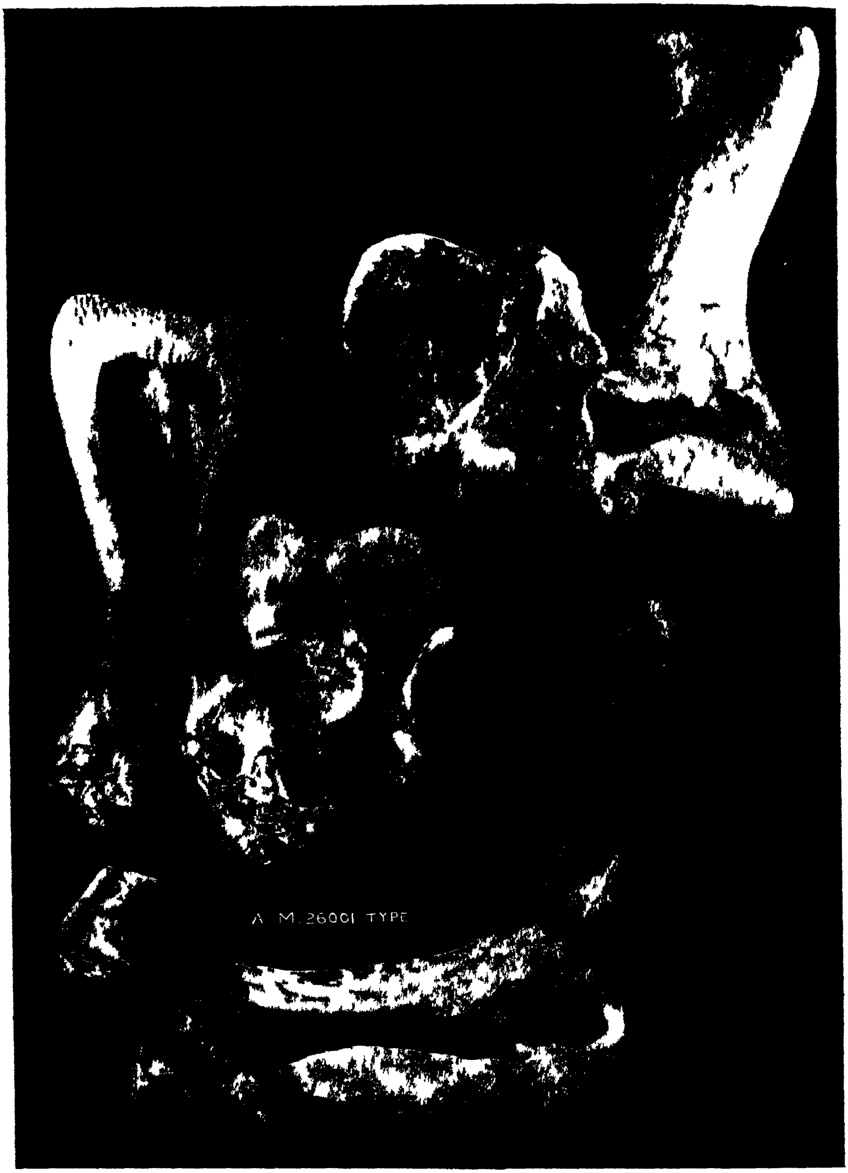

Fig. 4

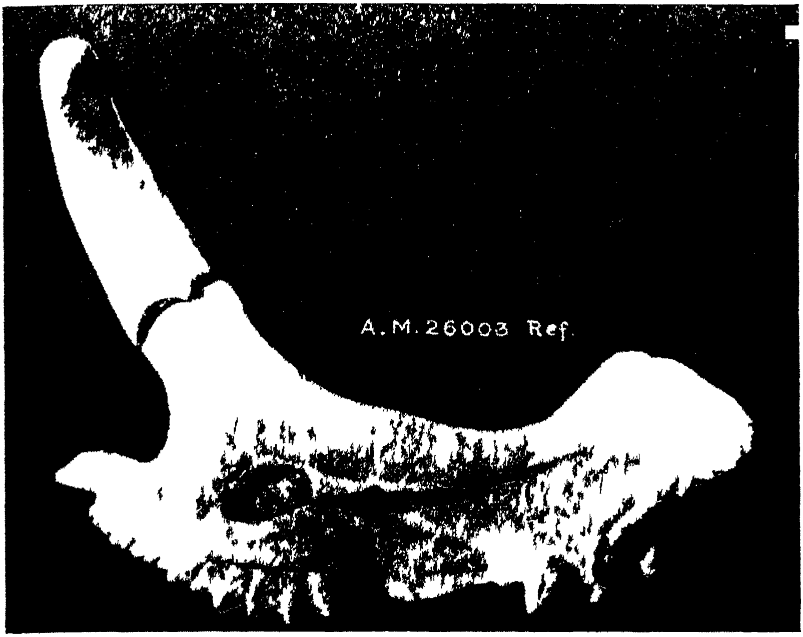

Fig 5 *Embolotherium andrewsi* Osborn, ref Field No 735, 1928 Coll, Amer Mus 26003 Ulan Gochu formation, Urtyn Obo section, level unrecorded Adult cranium of very large size, length from tips of complete premaxillaries to occipital crest, 940 mm or 3 ft 1 in Prepared in the Peking laboratory and repasted for shipment One-tenth natural size

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Fig 4 *Embolotherium andrewsi* Osborn, type Field No 750 1928 Coll, Amer Mus 26001 Ulan Gochu formation, Urtyn Obo section, "middle white" or 'gray" beds, 125 ft below Baron Sog unconformity Cranium with maxillary rostrum wanting, dentition damaged lateral oblique, posterior, and anterior aspects One-tenth natural size Compare figure 6

PRINCIPAL MEASUREMENTS

Length	
Summit of nasals to summit of occipital crest	1028 mm
Base of nasals to back of occipital crest	852
Auditory opening to front border of orbit	518–532
Height	
Occipital condyles to occipital crest	370
Lacrymal foramen to summit of nasals	594
Width	
Maximum width of nasals	342
Minimum width of nasals	180
Transverse of zygomatic arches	318
Transverse of occipital crest	440
Transverse of occipital condyles	194

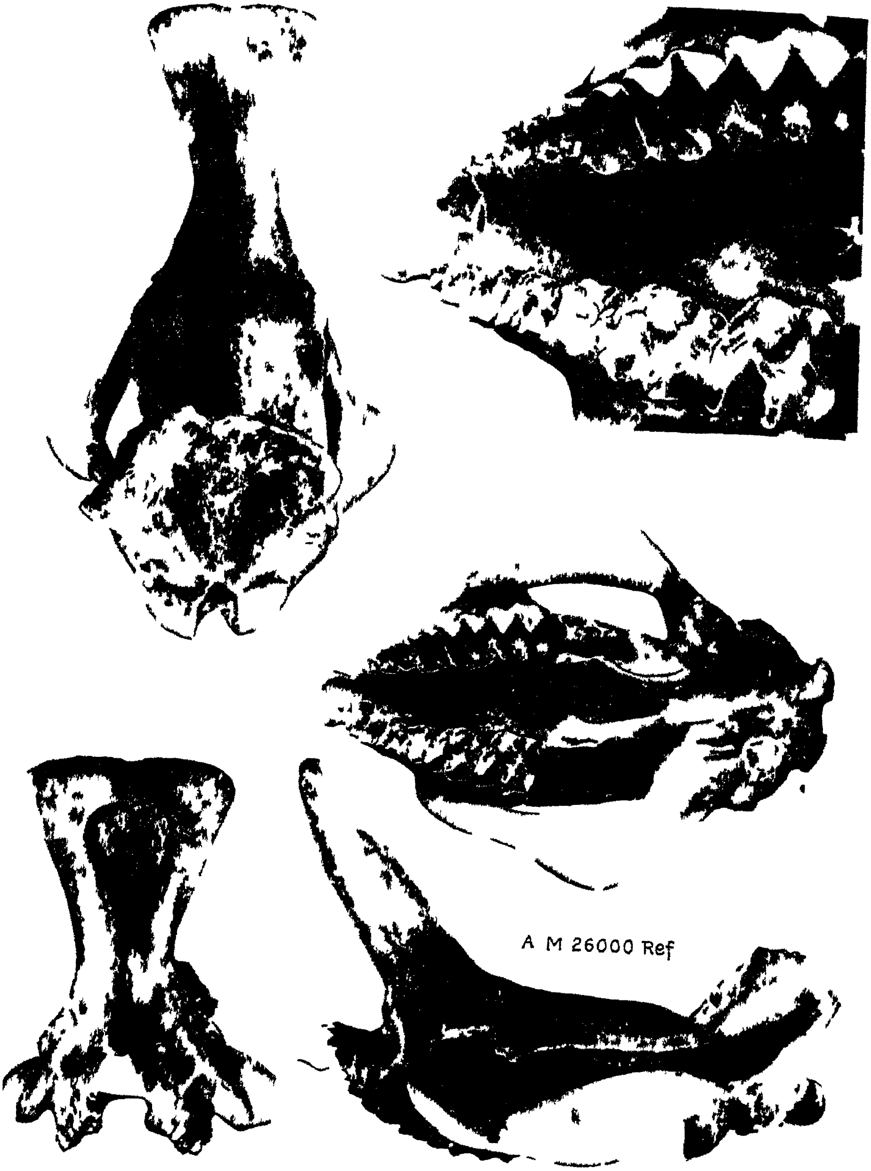


Fig 6

its horns in tossing, the 'embolothere' used its horns for battering, assaulting, attacking, and tossing. Hence the name "battering-ram-nosed titanothere" seems appropriate. From the front part of the face there arises a single bony horn, of completely novel form, composed of elongated and uplifted nasal bones; these bones are supported on a firm base of the frontals and maxillaries. In the genotypic species, *Embolotherium andrewsi*, the nasal horn rises to a height of 28 inches (Fig. 4) and expands very broadly at the summit into a rugose bony prominence, on the under surface of which is an upward extension of the anterior nares. This single nasal protuberance is totally different in structure from the paired frontonasal bony horn of all previously known titanotheres as shown by comparison with the frontonasal horn in the juvenile skull of *Brontops brachycephalus* or with that in the adult skull of *Brontotherium platyceras.* This profound structural difference was not realized until the juvenile skull of *E. andrewsi* revealed this wide contrast between *Embolotherium* and *Brontotherium.*

Embolotherium andrewsi, sp. nov.

Type.—Amer. Mus. 26001, figure 4. Cranium with maxillary rostrum wanting, dentition damaged.

Locality.—East Mesa, "middle white" or "gray" beds, Mongolia.

Horizon.—Ulan Gochu.

Specific Characters.—Premaxillo-maxillary rostrum reduced, abbreviate, bony horn rising above and anterior to the orbits, extremely broadened at the summits, infolding nasal chamber inferiorly. Known from three complete crania and other specimens found in the levels of the Ulan Gochu formation.

Fig. 6. *Embolotherium andrewsi* Osborn, ref. Field No. 708, 1928 Coll., Amer. Mus. 26000. Ulan Gochu formation, channel deposit, Ulan Shireh Obo section, top of "gray" beds or of "middle white" beds. Fully adult skull with complete nasals and fractured rostrum, and finely preserved grinding teeth. Presented to the Chinese Geological Survey Museum, December, 1928. Superior, anterior, lateral, and palatal aspects. One-tenth natural size.

Principal Measurements

Length:	
Premaxillæ to condyles	780 mm.
Occipital crest to center of nasal tip	770
Lacrymal process of orbit to tip of nasals	370
Premolar-molar series, P 1–M 3	310
Width:	
Transverse of nasal extremities	260
Transverse across zygomatic arches	500
Vertex across postorbital process	310

This superb animal, as fully represented in figures 4, 5, and 6, constitutes one of the greatest surprises in the long palæontologic history of the titanotheres, because it differs from all previously known forms in the single rather than the paired structure of the bony horn and in its composition, which is clearly shown in the young individual (Amer. Mus. 26040, *E. grangeri*), see figure 8. Whereas in all other titanotheres the bony horn arises from the frontals, overlapping the nasals which are gradually reduced in size, in the present animals no frontal horn is known to have developed, but the nasals (*Na*) composed the entire anterior prominence, carrying forward on the lower surface (Figs. 3, 4 and 8) the prolongation of the anterior nares. In brief, in all previously known titanotheres the frontals form the chief element in the horn and the nasals are reduced; in these embolotheres a complete change of function takes place, i e., the nasals form the anterior bony horn. There was much speculation about this by the author and by Dr. W. K. Gregory and others until a photograph of the juvenile skull of *Embolotherium grangeri* reached the Museum, which appeared to settle the question.

Such bony composition of the nasal horn is apparently characteristic of all three species, which, however, differ widely in the shape of the horn and in the abbreviation (*E. andrewsi*) or elongation (*E. grangeri*) of the premaxillary rostrum.

In *Embolotherium andrewsi* we apparently have the most extreme stage of embolothere development, in which the single horn is the longest, widest, and most prominent and the premaxillaries are the smallest and most reduced, as shown in the referred specimen of *E. andrewsi* (Amer. Mus 26003) represented in figure 5, after photograph in the pasted condition in the Peking laboratory.

Embolotherium grangeri, sp. nov.

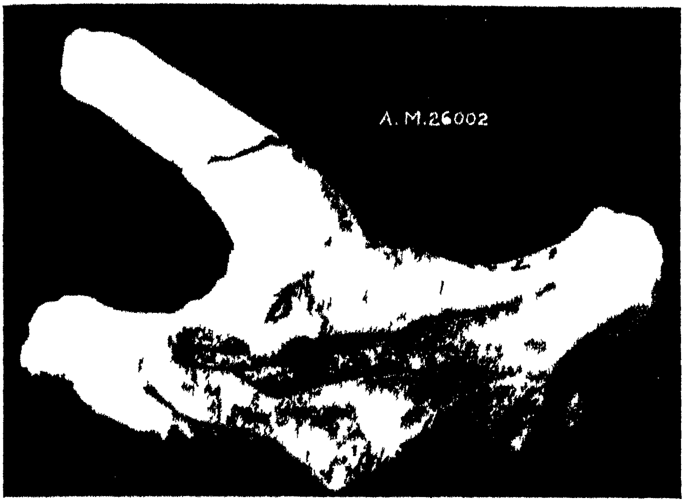
TYPE.—Amer. Mus. 26002, figure 7 (upper). Cranium with elongated rostrum.

LOCALITY.—East Mesa, "middle red" beds, Mongolia.

HORIZON.—Ulan Gochu.

SPECIFIC CHARACTERS.—Maxillo-premaxillary rostrum elongate, nasal bony horn extending upward and forward, slightly recurved on lower surface, with convex superior border, arising from mid-cranium somewhat posterior to orbit. Zygomatic arches very broad; summit of nasal protuberance moderately broad. Known from the type and other individuals found in the upper levels of the Ulan Gochu formation.

The present species in readily distinguished from *Embolotherium andrewsi* by three characters: (1) The elongation of the maxillo-premaxillary rostrum; (2) the elevation of the horn from the middle region of the cranium somewhat posterior to the orbits, whereas in *E.*



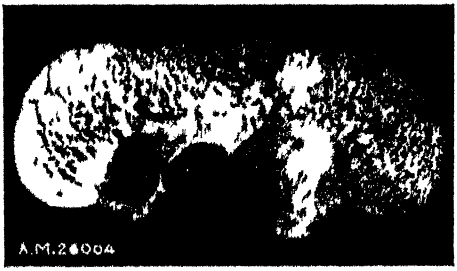


Fig. 7. (Upper) *Embolotherium grangeri* Osborn, type. Field No. 770, 1928 Coll., Amer. Mus. 26002. Ulan Gochu formation, Urtyn Obo section, base of "middle red beds," 195 ft. below Baron Sog, 65 ft. above Shara Murun. Type cranium with elongated rostrum as prepared in the Peking laboratory and repasted for shipment. One-tenth natural size.

Fig. 7. (Lower) *Embolotherium grangeri* Osborn, ref. Field No. 756, 1928 Coll., Amer. Mus. 26004. Ulan Gochu formation, Urtyn Obo section, "middle red beds." A complete skull base with top weathered off, tip of nasals with median suture and heavy septum ridge, heavy rugose extremity partly cartilaginous in this young individual (M^3 slightly worn). One-fifth natural size. Discovered on the level of *E. grangeri* type.

andrewsi the horn rises directly above the orbits as in other progressive genera of the titanotheres; and (3) the bony horn of *E. grangeri* presents a downward and forward curvature, being concave on the lower surface and convex on the upper or posterior surface, whereas in *E. andrewsi* the horn is convex anteriorly and concave posteriorly, as in the genus *Brontotherium*. As shown in side view the type of *E. grangeri* is a considerably smaller animal than *E. andrewsi*.

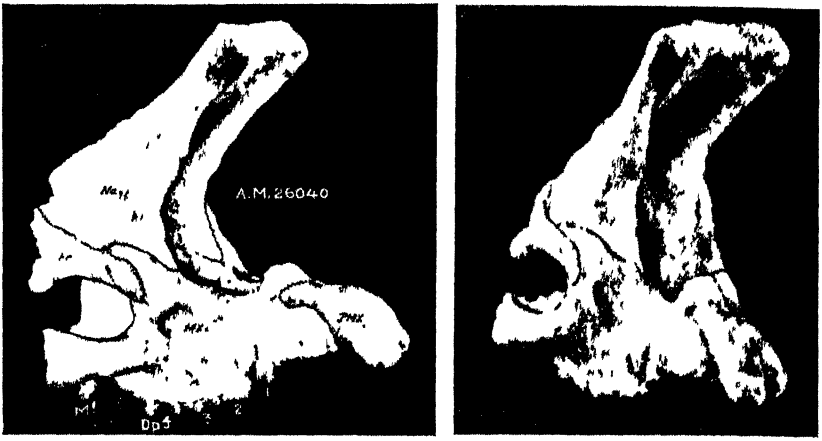


Fig. 8. *Embolotherium grangeri* Osborn, ref. Field No. 673, May 7, 1928 Coll., Amer. Mus. 26040. Ulan Gochu formation, Twin Oboes section. Juvenile cranium exhibiting sutures of *Na.*, *Fr.*, *Mx.*, *Pmx.*, in oblique frontal and lateral aspects. Lower edge of left nasal has been crushed downward and inward. About one-tenth natural size.

Embolotherium loucksii, sp. nov.

Type.- Amer. Mus. 21610, figures 9 and 10. Anterior portion of adult cranium, female (?).

Locality.—Base of "upper red beds," 4 miles north of Baron Sog Lamasery, Mongolia.

Horizon.—Ulan Gochu.

Specific Characters.—Premaxilla elongate, nasal protuberance with upward and forward curvature arising from middle portion of vertex and directly above orbits, straight superior border, relatively narrow at summit. Known from type specimen only.

This specimen is the first one discovered and was at once recognized as a very peculiar animal, in fact, it proved to be difficult to compare it with other titanotheres because it was obvious that the composition of the bony horn was entirely different. As admirably represented in figures

9 and 10, the nasal horn prominence rises directly above the orbits and extends directly forward and upward, unlike the recurved horn of *Embolotherium andrewsi* or the decurved horn of *E. grangeri.* On the inferior surface, as shown in figure 9, the lateral portions of the nasals are brought together and the very broad narial channel observed in *E. andrewsi* (Fig. 1) is wanting; the anterior nasal opening is correspondingly reduced; the nasal bony horn terminates in a rounded club-shaped expansion, quite different from the broad plate characteristic of *E. andrewsi.* As further shown in the photograph of the type (Amer. Mus. 21610 Fig. 10) the nasal horn rises directly above and anterior to the orbits, instead of behind the orbits as in *E. grangeri.* It would appear that the premaxillary rostrum is elongated, but this point is difficult to determine in the specimen now in hand.

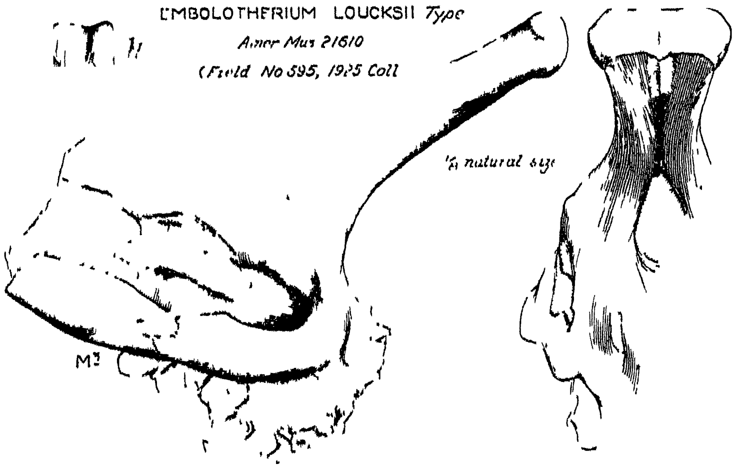


Fig. 9. *Embolotherium loucksii* Osborn, type. Field No. 595, 1925 Coll., Amer. Mus. 21610. Ulan Gochu formation, base of "upper red beds," four miles north of Baron Sog. Anterior portion of adult cranium, female (?). One-eighth natural size. See Fig. 10.

A striking fact is that the type of *Embolotherium loucksii* (Field No. 595, 1925 Coll., Amer. Mus. 21610) is reported by Granger as from the base of the "upper red beds," four miles north of Baron Sog. From this it would appear that the geologic level is about the same as that of *E. andrewsi*, although it may be hazardous to correlate these two levels at present.

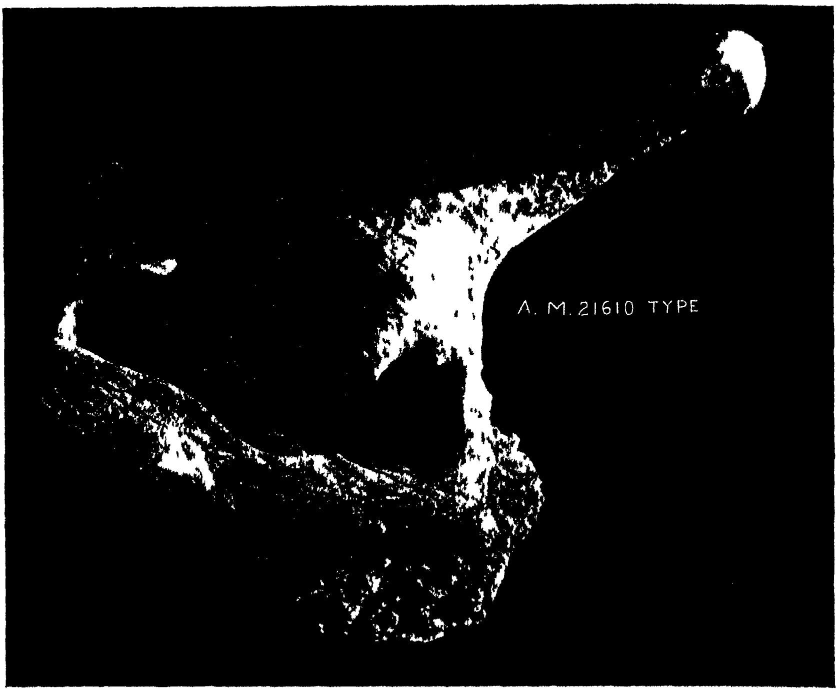


Fig. 10. *Embolotherium loucksii* Osborn, type. Field No. 595 (Amer. Mus. 21610). One-sixth natural size. See Fig. 9.

PRELIMINARY CONCLUSIONS

From the fundamental differences in cranial structure of the three species of *Embolotherium* above described, it seems without doubt that we have to do with three different subphyla of the genus *Embolotherium*, because it is certain that *E. loucksii* cannot be ancestral to *E. grangeri*, nor can either of these species be ancestral to *E. andrewsi*. Pending corroboration of this conclusion by the study of more complete materials, it appears that the Embolotheriinæ embrace at least three different phyla, which, when we come to examine their dental structure, may prove to be of different generic rank. This preliminary notice may close with a citation from the first announcement of the discovery of this extraordinary new branch of the titanothere family (see footnote, p. 1):

> First: Titanotheres, of Lower Oligocene age. Whereas in the Rocky Mountain region titanotheres reached their climax in the giant pair-horned *Brontotherium platyceras* of the Lower Oligocene, they survived and attained a superclimax in the

still larger and more unique battering-ram nosed *Embolotherium* (Greek ϵμβολή, signifying a battering ram) of the Oligocene of the Desert of Gobi. This animal somewhat exceeds in size the largest *Brontotherium* (flat-horned thunder beast) of North America and develops in the front part of its face an entirely novel nasal battering ram composed of combined nasal and frontal bones. As the brontotherium' used its horns in tossing, the 'embolothere' used its horns for battering, assaulting, attacking, charging, and tossing. This bony horn rose 28 inches in the very front part of the face and was broadly expanded at the summit. Roy Chapman Andrews informs us (August 22, 1928) that the ram-nosed titanotheres

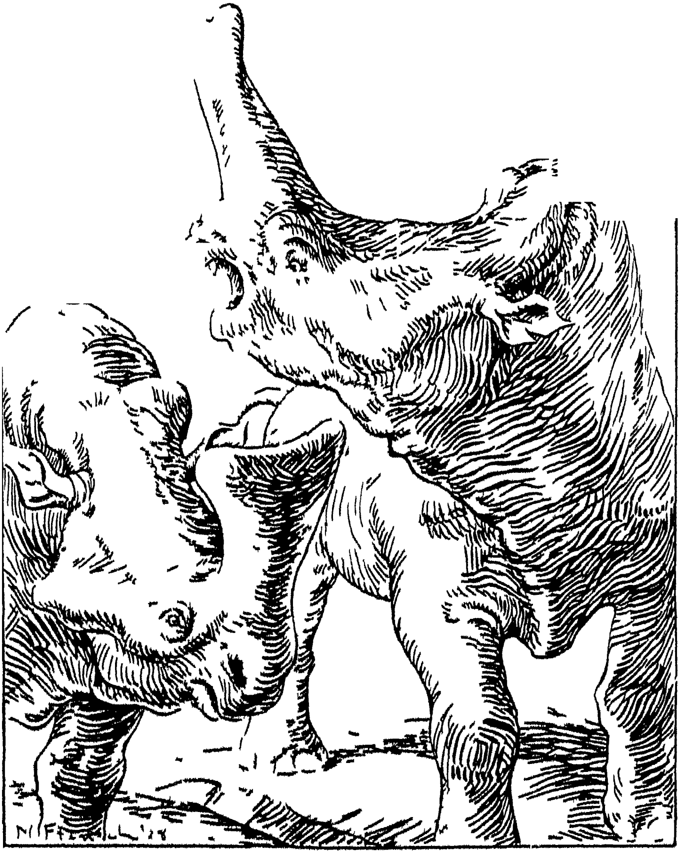


Fig. 11. Preliminary restoration of *Embolotherium andrewsi* based upon the structure of the cranium only. The other portions of the neck and body are restored with the characters of *Brontotherium platyceras*. About one twentieth natural size.

'are from the Ulan Gochu region, probably Middle Oligocene, and belong to the same group as the front portion of the skull found in the Shara Murun by Harold Loucks in 1925, although the new skulls are much larger than the Loucks specimen and are comparable to the largest of our American Oligocene titanotheres. There are no true horns but the frontal and nasal bones are produced upwards and terminate in a transversely broad blunt and rugose end. Fully as impressive as our finest American skulls, they surely represent a distinct phylum of titanothere.'

From the absence of any trace of embolotheres in previously described formations (Ardyn Obo, Shara Murun, and Irdin Manha) it would appear that they were from the first a separate branch of the superfamily Titanotherioidea, which developed in the plains region to the north of the Gobi Desert and finally migrated toward the end of Lower Oligocene time as far south as the southern Gobi where we meet their remains in great abundance and where they attained surpassing size and diversity. It also appears at present, but awaits corroboration, that they succeeded or replaced the genera and species of titanotheres common to the Asiatic and American plains, namely, *Brontops* and *Menodus*.

AMERICAN MUSEUM NOVITATES

Number 354

Published by
The American Museum of Natural History
New York City

June 5, 1929

56.9 (1181:4)

PALEOCENE AND LOWER EOCENE MAMMALS OF EUROPE

George Gaylord Simpson

INTRODUCTION

Continued stratigraphic and faunal study of the American Paleocene and Lower Eocene demands as much knowledge as possible of contemporaneous geologic and faunal events in western Europe. It is the purpose of the present note to facilitate study by giving a succinct review of current knowledge of the European mammalian faunas of these epochs. The subject has recently been placed on a new and incomparably more satisfactory basis by the fine French and Belgian studies of P. Teilhard de Chardin (especially 1921, 1927, see references), and the present résumé is primarily a review of his work, although it also takes into account the other literature of the subject. This is supplemented by some personal acquaintance with the French Thanetian. Some specimens of each of the genera of this fauna were studied, in which connection I wish to thank Doctors M. Boule, C. Depéret, and W. O. Dietrich; and a brief visit was made to the classic section along the Mont de Berru near Reims.[1]

FAUNAL LISTS

Thanetian of France. *Pleuraspidotherium-Neoplagiaulax* Zone

La Fère:
- *Arctocyon primaevus*

Merfy (Horizon of Sables moyens de Jonchery):
- *Plesiadapis ?tricuspidens*

Rilly and Chenay:
- *Plesiadapis ?tricuspidens*

Cernay-les-Reims:
- *Neoplagiaulax eocaenus*
- *Neoplagiaulax copei*
- *Liotomus marshi*
- *Adapisoriculus minimus*
- *Adapisorex chevilloni*
- *Adapisorex gaudryi*
- *Adapisorex* aff. *?dolloi*

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[1] Most of the known Thanetian mammals come from the Cernaysian gravel, a local stratum, so that it is customary to speak of the Cernaysian fauna. The name is derived from the village of Cernay-les-Reims (not to be confused with Cernay-la-Ville, which is in Seine-et-Oise) at the foot of the hill (Mont de Berru) on its west side, near the productive localities.

Dissacus europæus
Dissacus gaudryi
Plesiadapis tricuspidens
Chiromyoides campanicus
Arctocyon primævus
Arctocyonides trouessarti
?*Arctocyonides* spp.
?Mioclænid indet.
Tricuspiodon rutimeyeri
Pleuraspidotherium aumonieri
Pleuraspidotherium remense
Orthaspidotherium edwardsi

?THANETIAN

Jonchery, sables moyens—a supposedly Thanetian horizon, but the mammals reported by Lemoine (1880) and Depéret (1907), not restudied by Teilhard, suggest confusion with Sparnacian strata:
Arctocyon primævus ("*Arctotherium cloezi*")
cf. *Hyracotherium* sp. ("*Pliolophus*")
cf. *Hemiacodon* sp.

SPARNACIAN OF FRANCE. *Hyracotherium-Coryphodon* Zone

Meudon and Vaugirard:
?*Platychœrops* aff. *daubrei*
Paramys sp.
Pachyæna gigantea
Palæonictis gigantea
Hyracotherium cf. *leporinum*
Hyracotherium sp.
Coryphodon oweni

Épernay Region—Archaic part of the Faune Agéienne of Lemoine:
Palæosinopa osborni
Platychœrops daubrei
Paramys lemoinei
Paramys nanus
Paramys sp.
Proviverra pomeli
Esthonyx munieri
Phenacodus teilhardi
Hyracotherium sp.

Muirancourt (Soissonais):
Palæonictis gigantea

Sézanne:
?*Hyracotherium vismæi*

Pourcy:
Coryphodon eocænus
New, indet. (Depéret, 1907, p. 12).

Cernay-les-Reims (above Cernaysian gravel):
Coryphodon oweni

LANDENIAN[1] OF BELGIUM. *Hyracotherium-Coryphodon* Zone

- Orsmael:
    - *Peratherium constans*
    - Cf. *Adapisoriculus* sp.
    - *Adapisorex dolloi*
    - Insectivore, indet.
    - *Platychœrops orsmaelensis*
    - *Eochiromys landenensis*
    - ?*Heterohyus* sp.
    - *Omomys belgicus*
    - Oxyclænid, indet.
    - Mesonychid, indet.
    - Oxyænids or hyænodontids, spp. indet.
    - Cf. *Sinopa* sp.
    - Miacids, spp. indet.
    - *Phenacodus teilhardi*
    - *Paramys lemoinei*
    - *Paramys nanus*
    - *Microhyus musculus*
    - ?*Protodichobune* sp.
- Erquelinnes:
    - Plesiadapid, indet.
    - ?*Arctocyonides* sp.
    - *Hyracotherium* sp.
    - *Coryphodon eocænus*
    - *Adapisorex dolloi*
    - *Omomys belgicus*
    - *Paramys lemoinei*
    - Cf. *Oxyæna* sp.
- Leval:
    - *Coryphodon eocænus*
- Vinalmont:
    - ?*Hyopsodus* sp.

LONDON CLAY, ETC., OF ENGLAND. *Hyracotherium-Coryphodon* Zone

- Sands below London Clay—?Woolwich Beds.
    - Kyson:
        - *Peratherium colchesteri*
        - Gen. indet. ("Insectivorous bat" of Owen).
        - *Hyracotherium cuniculum*
    - ?Localities:
        - *Coryphodon* sp.
    - London Clay (All?):
    - Sheppey:
        - *Hyracotherium leporinum*
        - *Argillotherium toliapicum*[2]

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[1] *Sensu stricto*: the term is sometimes made to include the Thanetian, older than the restricted Landenian.

[2] Davies, 1884. A supposed creodont of uncertain affinities.

Coryphodon eocænus
Herne Bay:
Hyracotherium leporinum
Platychœrops richardsonii
Dulwich:
Coryphodon eocænus
Harwich:
Hyracotherium vulpiceps
Croydon:
Coryphodon croydonensis
CUISIAN OF FRANCE. *Propachynolophus-Lophiodon* Zone
Épernay Region—More advanced part of the Fauna Agéienne of Lemoine:
Protoadapis curvicuspidens
Protoadapis recticuspidens
Propachynolophus maldani
Propachynolophus gaudryi
Propachynolophus sp.
Chasmotherium stehlini
Lophiodon sp.
Protodichobune oweni
Fismes:
Lophiodon larteti

RANGE OF GENERA

1—Thanetian.
2—Sparnacian and equivalents.
3—Cuisian.
4—Post-Cuisian in Europe.

	1	2	3	4
MULTITUBERCULATA				
Ptilodontidæ				
Neoplagiaulax	×			
Liotomus	×			
MARSUPIALIA				
Didelphiidæ				
Peratherium		×		×
INSECTIVORA				
Leptictidæ				
Adapisorex	×	×		
Pantolestidæ				
Palæosinopa		×		
Nyctitheriidæ				
Adapisoriculus of Orsmael		×		
PRIMATES				
Plesiadapidæ				
Plesiadapis	×			
Chiromyoides	×			
Platychœrops		×		

	1	2	3	4
Eochiromys		×		
Heterohyus		?		×
Anaptomorphidæ				
Omomys		×		
Adapidæ				
Protoadapis			×	×
TILLODONTIA				
Esthonychidæ				
Esthonyx		×		
RODENTIA				
Ischyromyidæ				
Paramys		×		
CARNIVORA				
Arctocyonidæ				
Arctocyonides	×	?		
Arctocyon	×			
Mesonychidæ				
Dissacus	×	×		
Pachyæna		×		
Oxyænidæ				
Palæonictis		×		
Proviverridæ				
Proviverra		×		×
CONDYLARTHRA				
Phenacodontidæ				
Phenacodus		×		
Meniscotheriidæ				
Pleuraspidotherium	×			
Orthaspidotherium	×			
Tricuspiodontidæ				
Tricuspiodon	×			
AMBLYPODA				
Coryphodontidæ				
Coryphodon		×		
PERISSODACTYLA				
Hyracotheriidæ				
Hyracotherium		×		
Propachynolophus			×	
Lophiodontidæ				
Chasmotherium			×	×
Lophiodon			×	×
ARTIODACTYLA				
Dichobunidæ				
Protodichobune		?	×	
INCERTÆ SEDIS				
Adapisoriculus of Cernay	×	?		
Argillotherium		×		
Microhyus		×		

EUROPEAN CORRELATION

	Mammalian Étages France	Champagne Faunas of Lemoine	Belgium	England
Lower Eocene	Cuisian	Agéian	Upper Ypresian, or Ypresian, *sens. strict.*	?
			Lower Ypresian	London Clay
	Sparnacian		Upper Landenian, or Landenian, *sens. strict.*	Woolwich and Reading Beds
Paleocene	Thanetian	Cernaysian	Lower Landenian	Thanet Sands
	(Montian)			
?				
Cretaceous	(Danian)			

The Thanetian has produced mammals only in the region of Reims, in France, and chiefly from the gravel (so-called conglomerate) of Cernay. This Cernaysian gravel marks the end of Thanetian time (Depéret, 1906), but Teilhard (1921) suggests that the whole Thanetian of this region will be found to have a unified fauna. The fauna consists of multituberculates, insectivores, plesiadapids, creodonts, and archaic ungulates of peculiar character.

Mammals of Sparnacian age have been found at numerous localities in the Anglo-Franco-Belgian Basin, but not elsewhere in Europe.[1] The fauna is marked negatively by the absence of multituberculates and of the Thanetian ungulates, positively by the first appearance of rodents, perissodactyls, and artiodactyls. Tarsiids, esthonychids, oxyænids, proviverrids, coryphodonts, and phenacodonts also appear in collections for the first time, although some of them may have been present previously. Some Thanetian mammals continue with little apparent change.

Faunas definitely of Cuisian age have so far been recognized only in the Paris Basin, and adequate differentiation of the mammals of this étage must depend on future work. It seems to be chiefly distinguished by the replacement of *Hyracotherium* by *Propachynolophus,* and by the first appearance of true lophiodonts.

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[1] Beds of this age occur over a much larger area, and may eventually yield mammals elsewhere. Depéret (1907, Proc. 7th Int. Zool. Cong., Boston, p. 769) believes that the type of his *Lophiaspis maurettei*, from Palette, near Aix in Provence, is of Lower Ypresian age, although the beds in which it occurred are referred to the Middle Eocene (Lutetian) by Vasseur.

The Sparnacian doubtless includes several distinct zones, but despite the work of Depéret and others these cannot yet be clearly recognized. The London Clay has been referred to the Cuisian (see Stamp, 1921) on the basis chiefly of the invertebrates, yet its mammals are clearly very close to those of the typical Sparnacian, and older than those of the restricted Cuisian. A slightly earlier zone is seen in the Woolwich Beds, and perhaps the fauna of Orsmael in Belgium, but these cannot yet be distinguished on the basis of the known mammalian remains.

The upper limit of the Paleocene has been placed at three different levels. A common European usage is to include the whole of the lower Eocene, as here understood, to the summit of the Cuisian. Or it may be placed above the Landenian, in which case the Sparnacian is supposed not to include any lower Ypresian or Londinian equivalents and the latter are placed in the true Eocene as opposed to the Sparnacian and Thanetian Paleocene. Or, finally, it may be placed above the Thanetian and below the Sparnacian. In the light of the crucial mammalian evidence, and particularly of increased knowledge of equivalent American faunas (especially Matthew), there is little question that the latter is the more natural and practicable division, at least from the vertebrate standpoint.

The lower limit of the Paleocene will continue to be rather dubious from any point of view. The vertebrates cast no light on this problem in Europe. The American Puerco and Torrejon should be included in the Paleocene and are older than the Cernaysian. The lowest Thanetian may be a partial equivalent, or part or all of their span may be represented by the Montian, which is often included in the Paleocene, but which may be as old as the Lance. The stratigraphic problem is exceedingly complex, but would probably be cleared up by the discovery of adequate land vertebrate faunas.

AMERICAN EQUIVALENTS

Depéret, Osborn, Matthew, and Teilhard have worked out the homotaxy of American and European early Tertiary mammal-bearing horizons in a way that now seems very satisfactory and calls for little comment. The evidence is briefly presented, however, in connection with the data reviewed above.

The known Thanetian mammalian fauna compares as follows with those known from America:

Thanetian	American Allies
Neoplagiaulax *Liotomus*	Inadequately known, but close to American genera, Torrejon to Gray Bull.
Adapisoriculus	Affinities uncertain.
Adapisorex	*Leptacodon*, Tiffany.
Plesiadapis	*Plesiadapis*, Tiffany, Clark Fork.
Chiromyoides	Close to *Plesiadapis*.
Dissacus	*Dissacus*, Torrejon to Gray Bull.
Arctocyon	About intermediate between *Clænodon*, Torrejon, and *Anacodon*, Gray Bull, Lysite.
Arctocyonides	Very close to *Thryptacodon*, Tiffany, Clark Fork, Gray Bull.
Tricuspiodon	No close relatives in America.
Pleuraspidotherium	*Meniscotherium*, Clark Fork, Largo, Lost Cabin.
Orthaspidotherium	Probably allied to above, but no close relative in America.

That the Thanetian or Cernaysian fauna is typically Paleocene has long been recognized, and it has been correlated with the Puerco or Torrejon. Teilhard suggested correlation with our uppermost Paleocene horizons, especially the Tiffany, and this has been accepted by Matthew. Further study only serves to emphasize this homotaxy. Both the positive and negative evidence clearly imply an earlier horizon than our typical Eocene Sand Coulee or Gray Bull and a later horizon than our Torrejon. The correspondence with the Tiffany and Clark Fork is seen to be rather close. The presence of meniscotheres, suggested by Teilhard to indicate possible later age, is not anomalous, as the Thanetian genera differ from ours and are somewhat more primitive than *Meniscotherium*. Furthermore, meniscotheres do occur in the Clark Fork and probably in the approximately equivalent levels of the Paskapoo, although little known.

The deposits of the two continents are of quite different facies. The Cernaysian gravel was deposited in brackish estuarine waters, while the American deposits, although varied, were all formed on flood plains, in some cases probably at a considerable altitude. In the Cernaysian, the peculiar meniscotheres and *Plesiadapis* are common, arctocyonids and insectivores fairly frequent, other mammals rare. In the Mason pocket of the Tiffany, *Plesiadapis*, multituberculates, and marsupials are common, and the rest of the fauna consists largely of small insectivores and primates which are individually rare but so varied as to constitute a large part of the fauna. Outside of this pocket, the Tiffany contains mostly *Phenacodus* and *Periptychus*, with rare creodonts. The Clark Fork contains condylarths in abundance, frequent esthonychids and creodonts, with amblypods, meniscotheres, and primates relatively rare. The Bear Creek Fort Union represents a third very distinct American facies, with plagiomenids (elsewhere unknown in the Paleocene) very common, other insectivores and the peculiar primate *Carpolestes* frequent, and creodonts, ungulates, and other groups relatively rare.

The fauna of the Cernaysian gravel differs little more from these three American faunas than they do among themselves. On account of these very marked differences due largely or entirely to facies, one hesitates to draw inferences from negative evidence. Yet it is very striking that in our Paleocene the ungulates are almost exclusively amblypods and phenacodonts, while in the contemporaneous European fauna these groups are quite unknown and their places are taken by three genera peculiar to that continent, only one of which has a close ally (and that rare at this level) in America.

The Sparnacian and Wasatch are still more similar, as the following list shows:

Sparnacian and Equivalents	American Allies
Peratherium	*Peratherium*, Gray Bull to John Day.
Adapisorex	*Leptacodon*, Tiffany; leptictids, Cretaceous through Oligocene.
"*Adapisoriculus*"	Nyctitheriidæ, Upper Paleocene to Middle Eocene.
Palæosinopa	*Palæosinopa*, Wasatch and Wind River.
Eochiromys	*Labidolemur*, Tiffany.
Platychœrops *Heterohyus*	[1]
Omomys	*Omomys*, Gray Bull, Lysite, Lower Bridger.
Protoadapis	*Pelycodus*, Sand Coulee to Lost Cabin.
Esthonyx	*Esthonyx*, Clark Fork to Lost Cabin.
Paramys	*Paramys*, entire Eocene.
Dissacus	*Dissacus*, Torrejon to Gray Bull.
Pachyæna	*Pachyæna*, Wasatch and Wind River (Gray Bull species).
Palæonictis	*Palæonictis*, Gray Bull.
Proviverra	*Proviverra*, Lower and Middle Eocene.
Phenacodus	*Phenacodus*, Clark Fork to Lost Cabin.
Coryphodon	*Coryphodon*, Clark Fork to Wind River.
Hyracotherium	*Eohippus*, Wasatch and Wind River.
Protodichobune	*Diacodexis*, Wasatch and Wind River.
Microhyus	Affinities unknown.

The current view that the Sparnacian and Wasatch are homotaxial is obviously correct. The faunas are almost identical. Not only essential contemporaneity, but also free intermigration or immediate derivation from a common source are indicated. The transition from the Paleocene to the Eocene is very similar in the two continents. In both, some Paleocene genera and phyla survive, but in both the transition is especially marked by the introduction of new groups from some unknown source.

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[1] These genera, or very close relatives, may occur in the Wasatch, but the evidence is not yet wholly available.

It has already been suggested that the various Sparnacian faunules of Europe are not exactly contemporaneous. In general, they appear to be close to the Gray Bull, but the fauna of Orsmael retains some special affinity with the Paleocene, and may be earlier, although it is certainly post-Thanetian. The conventional Sparnacian may include some Lysite equivalents, but there is no definite evidence of this.

There are apparently no groups of mammals which appear in the European Paleocene or lower Eocene before they appear in America. Of the several cases in which the reverse seems to be true, only that of the phenacodonts is worthy of emphasis. This group (*Tetraclænodon*) was very prominent in America before the Cernaysian gravel was deposited in Europe, yet it does not appear in the latter continent until the Sparnacian. It is quite possible, however, that it will yet be found in Paleocene beds there of facies different from the Cernaysian. The case of *Coryphodon* is not analogous, for this genus was not derived from any known earlier American form, and the Clark Fork, where it first appears, may be slightly younger than the Cernaysian. In the Clark Fork, *Coryphodon* appears and *Periptychus* is absent, while in the Tiffany, nearly contemporaneous but possibly a little earlier, *Periptychus* survives, but *Coryphodon* is absent.

The Cuisian is apparently homotaxial with the Wind River, or with the later Wind River and earliest Bridger. It marks the beginning of that divergence between the mammals of America and Europe which is increasingly apparent in the middle and upper Eocene.

SOME NOTES ON NOMENCLATURE AND AFFINITIES

ADAPISORICULUS AND ADAPISOREX

Lemoine referred to his species *Adapisoriculus minimus*, four specimens from Cernay. Of these, only one is mentioned by Teilhard, a fragment of a lower jaw with a single molar, the original of Lemoine 1885, Pl. XI, Fig. 13. The original of Pl. XI, Fig. 14, is a nearly complete lower jaw with a single tooth which does not agree well with the other tooth, the lectotype. The other two specimens, Pl. XI, Figs. 15–16, are fragments of jaws without teeth. The genus thus rests on a single tooth, redescribed and accurately figured by Teilhard (1921, p. 17, Fig. 8F; Pl. I, Fig. 3). It is somewhat imperfect, the tip of the metaconid and all of the protoconid broken off.

In the Université de Lyon is a perfect lower molar collected at Cernay by Professor Depéret, who kindly permitted its study. It is larger than the type of *Adapisoriculus minimus* and has a relatively larger metaconid.

Lemoine considered *Adapisorex* and *Adapisoriculus* as closely related insectivores. In 1921, Teilhard treated them together under "les Insectivores," but suggested that "*Adapisoriculus* pourrait bien être un Didelphe." In 1927, however, he considered *Adapisoriculus* as an insectivore, on the basis of new specimens referred to the genus, derived from the Landenian at Orsmael.

Teeth of this primitive tuberculo-sectorial type occur in several orders, and the attribution of isolated specimens is exceedingly difficult. In the Orsmael specimens, two of which include the alveoli of the cheek teeth, the formula seems definitely to be P^3 M^4. This would establish this animal as an insectivore, and it is suggestive of the Nyctitheriidæ, reference to which is confirmed by an upper molar later described by Teilhard (1928).

It does not seem certain, however, that this Orsmael animal is really *Adapisoriculus minimus*. It seems to be distinctly smaller, the heel longer and lower relative to the trigonid, the hypoconid-metaconid crest more definite, the hypoconulid slightly less internal. It is just such minutiæ which separate the primitive lower molars of several distinct orders in the older Tertiary. It still seems quite possible that the original impression of Teilhard—an impression which was very strongly my own also after studying the originals—was correct, and that the true Cernaysian *Adapisoriculus*, and also the Lyons specimen, are didelphids.

Adapisorex has generally been considered as representing a distinct family, Adapisoricidæ, allied to the Tupaiidæ, but Teilhard's recent memoir (1927, pp. 10–11) indicates that it is a leptictid. Its closest American ally appears to be *Leptacodon*, with which Teilhard was unable to compare it. *Leptacodon tener* differs from *Adapisorex dolloi* chiefly as follows:

Posterior mental foramen somewhat more anterior.

Paraconid of P_4 more distinct, heel narrower and less sharply cut off from trigonid.

Lower molars relatively longer and narrower, paraconids relatively larger, heels wider relative to trigonids.

All of these characters, however, are variable in the different species referred to *Adapisorex*. The known specimens of *Adapisorex chevilloni* cannot be distinguished generically from *Leptacodon*, although there are various distinctions of specific value from *L. tener*, such as its somewhat greater size.

This modified conception of *Adapisorex* reopens the question of the supposed extinct tupaioids, a subject too complex to pursue further here.

PLATYCHŒROPS-PLESIADAPIS

Platychœrops richardsonii Charlesworth 1854 was based on a partial palate from the London Clay of Herne Bay. The original description was published anonymously and was very brief, but it was ascribed to Charlesworth and gives a diagnosis, so that it must be recognized as valid. The same specimen was subsequently described and figured by Owen (1865), who considered the animal as a hyracothere. He made no reference to the previous name, but called it *Miolophus planiceps*. Lydekker (1887, Cat. Fossil Mammalia, British Museum, Vol. V, p. 4; and elsewhere) used the correct name, *Platychœrops*, and, recognizing that it was not an ungulate, considered it as closely allied to *Esthonyx*.

Teilhard (1921, p. 62) recognized, for the first time, the true affinities of this strange species. It is a plesiadapid certainly congeneric and possibly conspecific with "*Plesiadapis*" *daubrei* Lemoine 1879. The genus *Plesiadapis* dates only from 1877 when the genotype *P. tricuspidens* Gervais was established on material from the Thanetian at Cernay-les-Reims. Considering the two genera as synonymous, Teilhard yet adopts the later name as better known.

Lemoine recognized two subgeneric groups of *Plesiadapis:* the *Tricuspidens* group, which is Thanetian, and the *Subunicuspidens* group, which is Sparnacian ("Agéien"). As recognized by Teilhard, these are natural divisions, quite distinct and not directly ancestral and descendant, although closely related. A valid and very convenient solution of this problem is to recognize these groups as separate genera. The Thanetian genus is *Plesiadapis*, the Sparnacian *Platychœrops*.

The chief distinctions, which are clearly of generic value by present mammalogical standards, are as follows:

	Platychœrops	*Plesiadapis*
1.	I^2 with two apical cusps.[1]	Three.
2.	No paraconule on P^4.	Prominent paraconule on P^4.
3.	Molar cusps generally subcrescentic.	Molar cusps more bunoid.
4.	Molar mesostyle strong.	Weak.
5.	P_3 partly, P_4 wholly molariform.	P_3 and P_4 similar save for incipient metaconid on P_4. Not molariform.
6.	On M_{1-2} metastylid large, paraconulid present.	Metastylid small or absent, paraconulid absent.
7.	M_3 with para- and metaconulids. Heel more complex.	No para- or metaconulids. Heel simpler.

The distinction is the more interesting in that it lends emphasis to the fact, noted in different words by Teilhard, that it is *Plesiadapis* which occurs in the American upper Paleocene (*Nothodectes* Matthew) and not *Platychœrops*.

EOCHIROMYS-LABIDOLEMUR

Teilhard (1927, p. 15) expresses the wish that precise comparison might be made between *Eochiromys*, from the Landenian of Belgium, and *Labidolemur*, from the Tiffany of Colorado (and, now, upper Fort Union of Montana). Thanks to his excellent figures and to the availability of the originals of *Labidolemur*, this can now be done.

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[1] Except in the plesiadapid from Meudon (Teilhard 1921, p. 51), which otherwise agrees with *Platychœrops* so far as may be judged from isolated teeth.

The lower incisors are very similar. That of *Labidolemur* has the crown slightly more curved and the posterior part of the upper crest more denticulate. In *Eochiromys* there are two single-rooted teeth between the incisor and M_1. In *Labidolemur* there was probably only one, but the specimens are broken and two may have been present. The molars, of peculiar pattern, are similar in the two genera almost to identity. Teilhard's figures suggest somewhat better differentiation of the talonid cusps in *Eochiromys*.

In *Eochiromys* there are two mental foramina, but they may open into a common deep groove. In *Labidolemur* this groove is still deeper and the foramina are closer together, so that the effect is of a single foramen. In both, the posterior part of this combined foramen is beneath the anterior end of M_2. The two known species of *Labidolemur* are somewhat larger than *Eochiromys landenensis*.

Teilhard's suggestion of relationship between these genera is fully substantiated. Of characters of possible generic value, there is little to distinguish them beyond the probable presence of only one premolar and the less distinct talonid cusps in *Labidolemur*— both rather doubtful features. The genera are either identical or very closely related.

As suggested by Matthew and by Teilhard, it is probable that at least two quite distinct groups are included in the Plesiadapidæ as currently used, although it is difficult to separate them. One, exemplified by *Plesiadapis*, *Chiromyoides*, *Platychœrops*, and possibly by *Trogolemur* and *Uintasorex*, generally has the lower incisor less enlarged, the mental foramen farther forward, and retains two or three premolars. In this group the molars are very lemuroid in structure. In the other group, exemplified by *Labidolemur* and *Eochiromys* and perhaps including *Heterohyus*, *Phenacolemur*, and *Apatemys*, the incisor is usually larger, often with limited enamel band, the mental foramen is far back, and the premolars number one or two. The molars of this group are definitely less lemuroid and the trigonids are quadrate.

Phenacodus teilhardi, new name

It is proposed to replace *Phenacodus europæus* Teilhard 1927, *non Phenacodus europæus* Rütimeyer 1888, by the new name *Phenacodus teilhardi*. Rütimeyer's name was incorrect, as the animal was later found to be an artiodactyl and called *Meniscodon europæus*, but the homonymy nevertheless invalidates the later name according to the accepted codes of nomenclature. Teilhard recognized the homonymy, but did not consider it deterrent.

PLEURASPIDOTHERIUM AND ORTHASPIDOTHERIUM

The work of Teilhard (1921, pp. 37–47) leaves little further question as to the long disputed immediate affinities of *Pleuraspidotherium.* It seems to be a relative of the American Upper Paleocene and Lower Eocene *Meniscotherium.*

The dentition of *Pleuraspidotherium* seems, on the whole, more primitive than that of *Meniscotherium.* P_4 is molariform in both, but in *Pleuraspidotherium* it is less lophiodont and the trigonid and talonid are less separated externally. In the lower molars the trigonid and talonid are less equal in height and the ridge from metaconid to hypoconid is not so strong. As in *M. tapiacitis,* but not other species of *Meniscotherium,* the metastylid is weak or absent. In the upper molars, the external cusps are less selenodont, the mesostyle not so much produced or reflected, the pseudhypocone (apparently a displaced metaconule) less elongated internally, except on M^3, the protoconule somewhat smaller, and the secondary metaconule (a cuspule on the anterior limb of the pseudhypocone in *Meniscotherium*) very weak or absent. In *Meniscotherium* there is also a small, sharp cingular cusp anteroexternal to the protocone which is absent in the European genus. The general resemblance in the dentition is very striking, however, and no other similar pattern occurs in the Eocene.

On the humerus, the greater trochanter is smaller in *Pleuraspidotherium;* the entepicondyle is more slender and lacks the foramen,—a remarkable feature,—and the trochlea is more cylindrical, less deeply grooved and crested. The ilium is less curved, with a lower crest and less prominent rectus femoris origin. The femur is quite similar to that of *Meniscotherium,* but the lesser trochanter is more produced, less platelike, the third trochanter is more proximal and less prominent, and the patellar groove is shorter and wider.

Teilhard states on the authority of Matthew that on the astragalus of *Pleuraspidotherium* the trochlea is more deeply grooved, the internal crest stronger than in *Meniscotherium.* This is imperfectly substantiated by an astragalus in my possession, on which these differences are very slight. As in *Meniscotherium,* the trochlea is considerably shallower and the internal crest much lower than in *Phenacodus,* for example, and these features constitute a point of resemblance rather than of distinction. The arrangement of the inferior facets is typically condylarthran, very like *Phenacodus.* The typical development in *Meniscotherium* of the inferiointernal process of the body is exactly similar in *Pleuraspidotherium.* The greatest distinction lies in the presence in the latter genus of a small astragalar foramen. In spite of this, I believe that the astragalus tends to support the suggested relationship. The Clark Fork *Meniscotherium* (?) *priscum* Granger may prove to be more nearly comparable with *Pleuraspidotherium* in structure, as it is in age, but it is very little known.

The case for *Orthaspidotherium* is by no means so clear. As Teilhard has fully shown, it is quite unlike any known American mammal. It also differs considerably from *Pleuraspidotherium* in many respects, but, no closer comparison offering, there is sufficient resemblance to warrant its tentative placing in the Meniscotheriidæ.

The broader relationships of these genera have also been much debated. The excellent American material requires thorough restudy in the light of the suggestion of Teilhard and others of relationship to the Hyracoidea. Schlosser's suggestion of relationship between *Meniscotherium* and the Perissodactyla, and between *Orthaspidotherium* and the Artiodactyla, is highly improbable.

TRICUSPIODON

The lower teeth of this genus were redescribed and carefully evaluated by Teilhard (1921, pp. 34–36), who concluded that the genus may be referred to the Periptychidæ in a distinctive subfamily. In 1920 (p. 118) Schlosser described an upper jaw, with two molars, which he made the type of a new species, *Arctocyonides lemoinei.* In a supplementary note (1921, p. 107) Teilhard suggested that this might represent the upper dentition of *Tricuspiodon.*

After studying the original of "*Arctocyonides lemoinei,*" through the courtesy of Dr. Dietrich, I am inclined to believe with Teilhard that this belongs in *Tricuspiodon.* The essential characters of the genus are as follows:

> P_{3-4} with triangular trigonids, paraconid and metaconid present, small one-cusped heels. Enamel smooth on all teeth. Trigonids of M_{2-3} with three cusps. Metaconid slightly larger than paraconid, protoconid larger than either. Metaconid and paraconid closely approximated. Heels simple, with small hypoconulid, posterior on M_3 but not forming a third lobe. M^2 without parastyle, hypocone moderate and directly posterior to protocone, protocone widely separated from paracone and metacone, which are external, equal, not crescentic. Relatively large proto- and metaconules. M^3 reduced, hypocone absent or vestigial, metacone much reduced, contour oval.

These characters are suggestive of the periptychids in the molarized premolars and some other details, but they clearly cut the genus off sharply from any recognized periptychid, and the upper molars, especially, are quite without the characteristic periptychid stamp. They are suggestive of the Mioclænidæ, which led Schlosser to place the genus in this family (1923), but the dentition as a whole, if correctly associated, certainly could not belong to a mioclænid. *Tricuspiodon* is probably an archaic ungulate, but it is not close to any other known genus and cannot be placed in any established family other than the Tricuspiodontidæ.

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AMERICAN MUSEUM NOVITATES

Number 355
Published by
The American Museum of Natural History
New York City
June 8, 1929

59 51, 7A (729 2)

ACŒTES MAGNIFICA, A NEW SPECIES OF POLYCHÆTOUS ANNELID FROM MONTEGO BAY, JAMAICA, BRITISH WEST INDIES

A. L. Treadwell

Acœtes magnifica, new species

A single individual was collected by the writer on a muddy bottom in Montego Bay, Jamaica, British West Indies, in July, 1921. The specimen is incomplete, lacking an unknown number of posterior somites; 64 somites with a length of 110 mm. remain. Some of these were cut away for study and are loose in the bottle with the type. At the point of greatest width, in the region of the 14th somite, the body diameter is 15 mm. when measured to the ends of the parapodia. Immediately behind somite 14, there is a slight diminution in width and this continues without change to the end of the fragment.

The greatest width of the prostomium is 1.4 mm., which is the same as the distance from the base of the prostomium to the anterior margin of the larger eyes. The halves of the prostomium are distinctly rounded, each bearing the stout ommatophore with the large eye at the end (Fig. 1). The median tentacle arises at the antero-dorsal margin of the prostomium; its style about equal to the stalk of the eye in diameter; its cirrophore somewhat heavier. It is about one-third longer than the length of the prostomium, plus the eye stalks. The style tapers slightly to an acute tip and has a subterminal swelling. The lateral tentacles are not more than half as thick as the median, but resemble it in form. The palps have been lost.

The first parapodia (Fig. 1, where only one is shown) extend anteriorly, so that their distal margins are on a level with the anterior border of the eyes. Each has a dorsal and a ventral cirrus, similar in form to the median tentacle but heavier. On the inner face, just ventral to the dorsal cirrus, each setal lobe of the first parapodia bears a square-ended protrusion directed toward the eye. This carries a tuft of long delicate setæ.

The tenth parapodium (Fig. 2) is shown in posterior view. The main portion of the setigerous lobe is compressed antero-posteriorly and is nearly rectangular when viewed from behind. A single vertical row of heavy setæ arises along its outer margin. On the antero-dorsal face of this portion is a thin, flattened lobe extending dorsally beyond the margin, but ventrally it is less than half as high. In figure 2 the cirrus-like structure just ventral to the dorsal cirrus is a gill and the shaded part just behind it is the upper part of this thin lobe. The dorsal cirrus is heavy and ends in a blunt point. The ventral cirrus is elongate-lanceolate in form and does not extend as far as the end of the setal portion On the dorsal and anterior face of the parapodia are a number of bladder-like gills, some of which are shown in Fig. 2 Ventrally there is a regular arrangement of these gills in a single row on each parapodium, three or four in number, situated on the parapodium between the point of origin of the ventral cirrus and the parapodial base. Two aciculæ, one large and one small, lie in each parapodium. Later parapodia are essentially like the tenth in form, though there is some increase in length and the gills are larger and more swollen On either side in each parapodium is a large golden-colored chitinous rod much larger than the acicula and entirely unconnected with it. One end is narrow and lies in a glandular mass near the laterodorsal face of the intestine. From here it extends ventrally and bends on

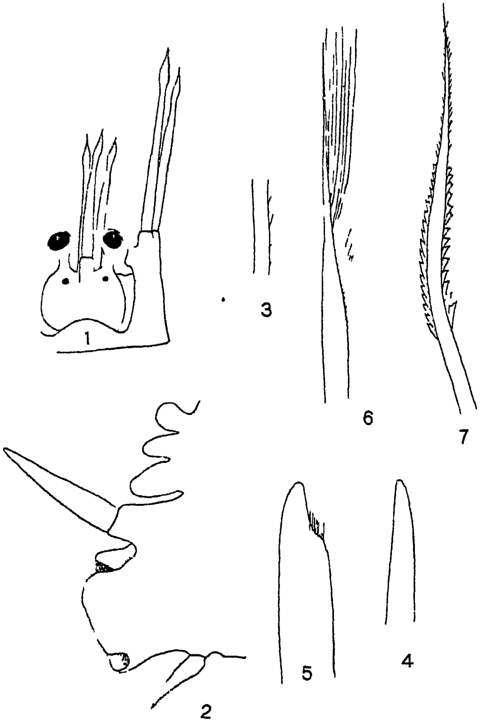

Fig. 1. Head, × 5. Fig. 2. Tenth parapodium, × 10. Fig. 3. Detail of fine seta, × 250. Fig. 4. Heavy seta from tenth parapodium, × 68. Fig. 5. Heavy seta from posterior parapodium, × 68. Fig. 6. Dorsal seta, × 150. Fig. 7. Ventral seta, × 150.

itself to form a large circle equal in diameter to the height of the parapodium, finally bending outward to the anterior face of the latter, where it ends just posterior to the thin flap mentioned earlier. A similar structure has been described in *Panthalis oculea* (Treadwell, 1901, p. 189, Fig. 15). In *Acœtes* a single one of these was 12 mm. long and measured 0.5 mm in diameter at the outer end.

The setæ of the first parapodium are very long and slender, extending beyond the head. They arise in two tufts, one on the protrusion which is directed toward the eye, the other below the dorsal cirrus. They are of uniform width throughout most of their length but taper rapidly to a sharp point at the end Along one side there are regularly repeated teeth, looking like single, needle-shaped spines, but probably in reality transverse rows of small spines. A detail is shown in Fig. 3. In subsequent parapodia there are three sorts of setæ. The first lie in a single vertical row about six in number, protruding from the outer face of the setigerous lobe. They are very heavy and in one from the tenth somite the end is bluntly rounded (Fig. 4). In one from a later somite there is a subterminal depression filled with a series of fine spines (Fig. 5) So many were broken that I was unable to determine the precise distribution of these two types. Near the dorsal end of the setal lobe, arising between the larger portion and the flap above mentioned, is a tuft of setæ of the form shown in Fig. 6. Each has a stout stalk, narrowing rapidly near the apex and continuing as a slender sharp-pointed portion. At the point where the narrowing begins is a tuft of stiff bristles and beyond these is a dense mass of long bristles which extend beyond the end of the stalk. The figure shows them in profile, though they are much more numerous than is represented there. In full face they look like a much frayed paint brush. At the ventral angle of the setal lobe is a tuft of a third kind of setæ. These vary considerably in length but are never as long as the dorsal ones. Each (Fig. 7) has a slender, curved stalk, sharp-pointed at the end and provided terminally with two rows of toothed plates which merge into single spines at the end.

The elytra show peculiar size variations for, while those of the first pair are large and must have covered the head during life, those of the second pair are not more than half as large as either the first or third. The sixth parapodium on one side (that of the other is lost) is also not more than half as large as those near it. When the animal was caught it swam rapidly with the elytra held above the back at an angle of about 40° with the dorsal surface of the body. If this was its habit, the elytra might easily have been bitten off or otherwise injured and the small size be due to regeneration. An average sized elytron measured 13 by 6 mm. in its two diameters, the general outline being oval. Behind about somite 40 they overlap from opposite sides, covering the dorsal surface. Between somites 14 and 40 a part of the dorsal surface is uncovered. This is due to the greater body width in that locality. The margin of the elytron is perfectly smooth and free from cilia, and there are no spines on the surface. The surface is divided by intersecting lines into five- or six-sided areas. Over a considerable part of its surface these lines are brown, giving this portion a distinct brownish tinge, though uncolored areas occur even here. In other portions the lines are not so brown and are distinguished from the general surface by their greater density. Near the upper free edge the elytron has a denser accumulation of brown granules. The general effect of the whole is that the body appears to be nearly colorless but with a slight brownish tinge. The body itself is uncolored except for some fine transverse brown lines on the dorsal surface.

The type is in The American Museum of Natural History (A. M. N. H. No. 1694).

Acœtes was first defined by Audouin and Milne Edwards (1834, pp. 99 and 102, Pl. II*a*, figs. 7 to 14), with *A. pleei* as genotype. In the arrangement of eyes and first parapodia their figures show no essential differences from *Panthalis*. They say that there are five antennæ, but their figures show plainly that they counted the palps as antennæ. The distinguishing feature of the genus is the possession of the bladder-like gills. Chamberlin (1919, p. 85) defines *Acœtes* as "with branchia; first parapodia normal," and *Panthalis* as "without branchia; first parapodia abnormal." His later figure of *Panthalis* indicates that by "abnormal" he means the extension of the first parapodia forward on the sides of the head, which Audouin and Milne Edwards clearly figure in *Acœtes pleei* The essential differences seem to lie in the presence or absence of gills, and on this basis I have assigned the above species to *Acœtes*.

Acœtes is evidently a rare genus, since *A. pleei* is the only one I have found mentioned in the literature. *A. pleei* came from Martinique; *A. magnifica* from Jamaica. It seemed possible that they might be identical, but while the description of *A. pleei* is not always clear, the figure of the head region shows that it has much shorter stalks to the anterior eyes; and the antennæ and first parapodial cirri are quite different, being smaller and having no subterminal swelling The large chitinous rods resemble *Panthalis oculea*, but a reëxamination of that species, made possible through the courtesy of Dr. W. L. Schmitt of the U S. National Museum, shows that it certainly has no gills and in other respects is quite unlike *A. magnifica*

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AMERICAN MUSEUM NOVITATES

Number 357
Published by
The American Museum of Natural History
New York City
July 6, 1929

56 7,5 (117 78 1)

A NEW TELEOSTEAN FISH FROM THE NIOBRARA OF KANSAS

By L. Hussakof

An interesting species of fossil fish was recently sent to the American Museum for determination, by Mr. George F. Sternberg, of the Kansas State Teachers College, Hays, Kansas. The specimen consists of a small block of the yellowish chalk characteristic of the Niobrara formation (Cretaceous) of Kansas, on which are two small, deepened fishes, about three inches in length. Both are of one species, which apparently represents an undescribed genus.

Through the kindness of Mr. Sternberg, I here give a description of this new form. I am also indebted to Dr. W. K. Gregory, to whom the specimen was originally sent, for kindly placing it in my hands for study.

KANSIUS, new genus

Small fishes, with a general resemblance to *Holocentrus* in body form, fins, forked caudal, and in having one greatly enlarged anal fin-spine; but distinguished by the much smaller size (less than half the length of the Monte Bolca *Holocentrus*), and by the fact that the soft portions of the dorsal and anal fins are of different shape and lower, not higher, than the spinous portions. Origin of ventrals about opposite origin of pectorals. Operculum with a spinous process in its upper part (possibly more than one, but the specimen is defective here).

Vertebræ, 10 or 11 abdominal and about 14 caudal.

Type Species.—*Kansius sternbergi*, new species.

Named for the State of Kansas, which has yielded to science a great wealth of fishes and reptiles of Cretaceous age. The generic name is formed from the abbreviation *Kans.* +*ius*.

Kansius sternbergi, new species

Cotypes.—Two small fishes, represented mostly by impressions, on a block of yellowish chalk, 11.5 by 15 cms. One fish is almost entire, lacking only extremity of the caudal fin; total length (if complete) 78 mm. The second fish shows the entire caudal but lacks the head. The description is based on both fishes.

In the collection of The Kansas State Teachers College, Hays, Kansas. Catalog No 25.

Geological Formation and Locality.—Niobrara (Upper Cretaceous); one-half mile south of Castle Rock, Gove Co. (about 50 miles west of Hays), Kansas.

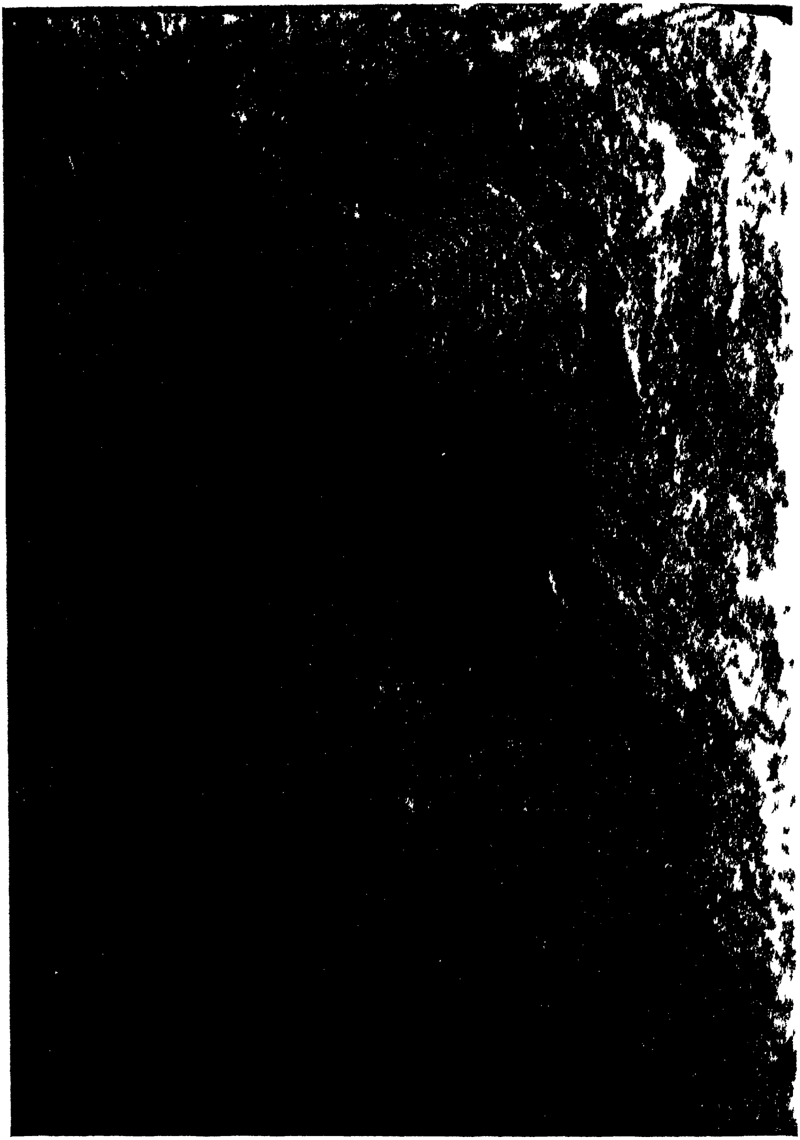

Fig 1. *Kansius sternbergi*, new genus, new species The two cotypes, on a small block of Niobrara chalk Natural size

A small fish, 78 mm. in total length (including caudal). Head slightly less than maximum depth; 3 times in total length.

Dorsal X or XI, and about 11 soft rays; its origin anterior to hind margin of operculum. Soft portion of dorsal follows immediately after spinous without a space between; base of soft dorsal a little more than half the base of spinous portion. Anal V[1], and about 8. Its origin opposite end portion of soft dorsal. Third anal fin-spine greatly enlarged and strong. This spine, under a lens, shows an ornamentation of low, anastomosing, longitudinal wrinklings or ridging.

Pectorals rounded, not reaching vertical through origin of soft dorsal. Ventrals with one spine and, apparently, more than 5 rays. (The number of rays cannot be counted exactly.) Origin of ventrals about opposite origin of pectorals, and opposite fourth spine of dorsal.

Caudal forked, with rounded extremities. Peduncle slender, about 10 in total length

The cranial bones are not preserved. but in the region of back part of skull there are indications of rugosities, and a spiniferous process is present near upper margin of operculum. A few minute teeth can be made out, with a strong lens, in the mandible. No statement can be made about the type of scales, since no complete scales are preserved.

Named for Mr. George F. Sternberg, whose extensive collections from the Cretaceous of Kansas made by himself, or (in former years) jointly with his father, the veteran field paleontologist, Mr. Charles H. Sternberg, are in many great museums of the world.

To determine the relationship of *Kansius* with certainty, we need to examine the cranial bones, which are not available in the present specimen. We must therefore be guided by less important characters, considered collectively, namely—the form of the fish, the position of the fins and the relative development of their spinous and soft portions, the forked caudal, small rounded pectoral, and, that peculiar feature, one greatly enlarged anal fin-spine.

These characters, taken together, agree best with the Holocentridæ (Squirrel-fishes), and I accordingly refer *Kansius* to that family.

The Holocentridæ were not previously known by fossil forms from America; but representatives of the family have been described from the Miocene of Malta, and the Upper Eocene of Monte Bolca, Italy,[2] and Regan has referred to this family several imperfectly known genera from the Cretaceous of England.[3]

Only a few genera of the small fishes of the Niobrara are as yet known, and *Kansius* is a welcome addition to the list. Considering the number of genera and species of large, predaceous fishes that have been described from the Niobrara, we must conclude that a considerable small-fish fauna existed to support them. But the conditions for the preservation of small, delicate forms were evidently not very favorable in that sea—not as favorable, for example, as in the case of the Cretaceous of Syria, from which many genera of small fishes have been described, exquisitely preserved in the fine-grained limestone of that formation.

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[1] In one of the cotypes (the lower fish in Fig. 1) three anal fin-spines are preserved—the enlarged one and two smaller ones posterior to it—and there is an indication that probably two additional small spines have been lost from the matrix in front of the enlarged one. In the second cotype (upper fish in Fig. 1), there is an impression of a small spine in front of the enlarged one, and a papilla-like spine seems to be present in front of this.

There is therefore no doubt about four anal fin-spines, with a strong probability that there were five, as in the existing *Holocentrus*.

[2] A. S. Woodward: Cat. Fos. Fishes Brit. Mus., Pt. IV, p. 412.

[3] C. Tate Regan: Ann. Mag. Nat. Hist., ser. 8, vii, 1911, p. 8.

The fact that two little fishes (and a fragment of a third) occur within the space of this small block, indicates that the Cretaceous genus was more or less gregarious, like existing Holocentridæ.

The greatly enlarged anal fin-spine calls for special comment. This character occurs in only a few families of teleosts, such as the Holocentridæ (Squirrel-fishes), Hæmulidæ (Grunts), and the Lutianidæ (Snappers). It seems to be best developed in the Holocentridæ It is remarkable that a seemingly unimportant character like this should persist for such a great length of time—from the Cretaceous up to the present day. It is even more remarkable that its ornamentation of very fine longitudinal wrinklings, which are hardly visible to the unaided eye, and for which we can conceive no function of service to the fish, should likewise have persisted during this vast period of time, unaffected by evolutional change

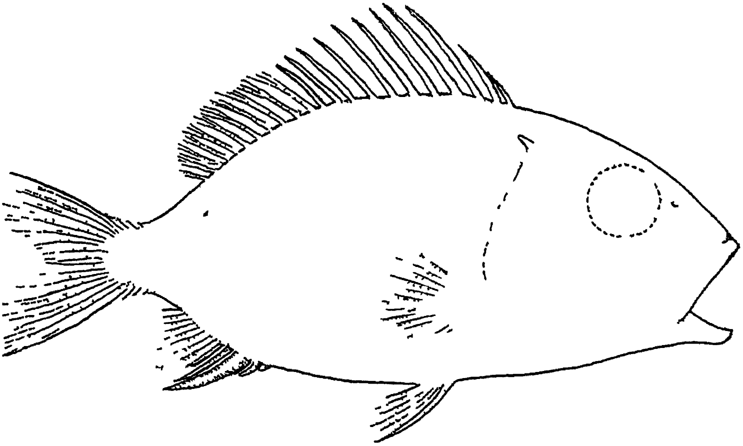

Fig. 2. *Kansius sternbergi.* Restored outline based on the two cotypes × 1⅓

An analogous case is afforded by the microscopic markings on the scales of teleosts, which, as Professor Cockerell has shown in his papers on fish scales, are constant in some families, so that it is often possible to identify the family to which a given fish belongs by only a few scales

AMERICAN MUSEUM NOVITATES

Number 356
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
July 2, 1929

59.82 (96)

BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. VII[1]

BY ROBERT CUSHMAN MURPHY AND GREGORY M. MATHEWS

Zosteropidæ

Zosterops flavifrons (Gmelin)

Excellent series of representatives of this species, from nineteen islands in the New Hebrides Archipelago, have failed to make it simple for us to work out the status of what appear to be six or more subspecies. The Whitney Expedition birds were collected at islands between Aneiteum, at the extreme south, and Vanua Lava of the Banks Islands, near the northern end of the group. The distance between these two stations is well over four hundred miles, and the variations that crop out among the birds are somewhat confusing.

Unfortunately, we have no specimens from Tanna, said to be the type-locality of the species, nor from the neighboring island of Eromanga. Our two skins from Aneiteum, which lies not far from Tanna, do not agree with the description of birds from the latter island. Moreover, the Aneiteum specimens are very unlike a series from Efate (Vate or Sandwich) Island. Now Sharpe (1900, Ibis, p. 346) specifically states that a specimen from Efate "agrees with others in the [British] Museum from Erromanga and from the typical locality of Tanna." Since our Efate specimens also agree perfectly with the published descriptions and figure of typical *flavifrons*, we are here regarding them as such and making them the basis of comparison.

Ultimately, the names now applied to the white-eyes of this group will probably need further revision, for the forms of *Zosterops flavifrons* seem to be closely akin to *Z. intermedia* of the Celebes Islands.

Zosterops flavifrons flavifrons (Gmelin)

Muscicapa flavifrons GMELIN, 1789, 'Syst. Nat.,' I, pt. 2, p. 944 (Tanna Island, New Hebrides Group).

Zosterops flavifrons, G. R. GRAY, 1873, in Brenchley's 'Cruise of the "Curaçoa,"' p. 366, Pl. VII, fig. 1; SHARPE, 1900, Ibis, p. 346; FINSCH, 1901, 'Tierreich,' Lief. 15, p 30 (part).

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[1] Previous papers in this series comprise American Museum Novitates, Nos 115, 124, 149, 322, 337, and 350

MEASUREMENTS.—(7 males, 4 females): wing, 59–63 (60.9); tail, 37–41 (40.2); exposed culmen, 13–13.5 (13.2); tarsus, 19–20 (19.6) mm.

RANGE.—Tanna, Eromanga, Efate and Nguna Islands.

Ten specimens from Efate, June 2–26, July 14–20, December 20, 1926; one from Nguna, July 31, 1926.

Nguna is an islet off the northern coast of Efate. The single bird from there is immature, but it seems to have the characters of the subspecies, which are highly distinctive and are not shared by specimens from any one of seventeen other islands in the New Hebrides and Banks Groups.

In adult examples of this subspecies the throat and breast are strontian yellow heightening to lemon chrome. From the nostril to the middle of the upper eyelid is a broad supraloral stripe of a still richer hue than the throat, ranging between lemon chrome and light cadmium. A band of the same color passes across the feathers at the base of the maxilla, joining the supraloral areas and supplying a reason for the name *flavifrons*. If our two specimens from Aneiteum are normal, there would certainly be no likelihood of the term *flavifrons* being applied to the *Zosterops* of that island.

The dorsal surface of the Efate and Nguna birds is mainly warbler green, slightly and indefinitely yellower on head and upper tail-coverts. The sides of head and neck are a little greener than pyrite yellow, and the flanks are olive-yellow. A strong infraorbital black streak outlines the anterior part of the white eye-ring. Iris, brown; bill, black (so appearing in the skins, and so marked on most of the labels), yellowish or horn-color at the base of the mandible; feet and legs, "gray." The condition of the gonads seemed to bear no reference to season.

Zosterops flavifrons macgillivrayi Sharpe

Zosterops magillivrayi SHARPE, 1900, Ibis, p. 345 (Malekula Island, New Hebrides Group); *Finsch*, 1901, 'Tierreich,' Lief, 15, p. 30.

SUBSPECIFIC CHARACTERS.—Differs from *Z. flavifrons flavifrons* in general reduction of color tone and loss of pattern; no infraorbital black streak; yellowish supraloral stripe never more than barely perceptible and usually lacking; forehead, crown, nape, sides of head, flanks, and upper tail-coverts, mainly warbler green; throat, breast, and flanks washed with the same color, leaving at most the center of belly and the under tail-coverts yellow; also, apparently, slightly smaller than the typical form.

MEASUREMENTS.—(4 males, 4 females): wing, 57–60 (58.4); tail, 37–39 (38.2); exposed culmen, 13–13.2 (13); tarsus, 18.5–19.7 (19) mm.

RANGE.—Restricted, so far as known, to Malekula Island.

Eight specimens from Malekula, August 17–26, 1926.

Several were breeding adults. A juvenal has a rusty tinge on the green dorsal plumage, and is somewhat ochraceous on belly and under tail-coverts. The flesh colors, as recorded, are those of the preceding form.

Sharpe was evidently much impressed by the different aspects of the birds of Efate and Malekula, for he compared the latter with *Zosterops rendovæ rendova* of the Solomon Islands, a species which is not closely related, being larger, of a quite different color, and without a circumorbital ring. He wrote, significantly, of the Malekula specimens. "They all lack the yellow on the forehead, in this respect agreeing with birds from Aneiteum." He adds, "They are of not such a bright yellow below as *Z. flavifrons*, and the greenish color of the flanks is therefore not in such evident contrast."

Sharpe included within his description a specimen from Epi Island, but we believe that Epi birds belong within another aggregation. Certainly the specimens from the single island of Malekula stand apart from those of any other locality in the entire archipelago as regards suppression of color and the general lack of contrasts in their plumage.

Zosterops flavifrons brevicauda, new subspecies

Subspecific Characters.—Resembling *Z. f. macgillivrayi*, but smaller, particularly in the length of the tail, and with more brightly colored under surface, especially on the throat, which is in some instances lemon chrome, as in *Z. f. flavifrons*.

Type.—No. 213,604, Amer. Mus. Nat. Hist.; ♂ ad.; Malo Island, New Hebrides Group; August 27, 1926; J. G. Correia.

Measurements.—(6 males, 1 female): wing, 55–60 (58); tail, 33–36.5 (35); exposed culmen, 12–12.7 (12.4); tarsus, 18–19 (18.4) mm.

Range.—Malo and Espiritu Santo Islands.

Four specimens from Malo, August 27; three from Espiritu Santo, August 30, December 4, 1926, January 13, 1927.

All but one were in breeding condition.

This form is very slightly different from the preceding, but it seems to have a consistently shorter tail, and more color in the throat and breast.

Malo is separated from the larger island of Espiritu Santo, or Marina, by only a narrow strait.

Zosterops flavifrons perplexa, new subspecies

Subspecific Characters.—Resembling *Z. f. brevicauda* in coloration, but slightly larger; wing and tail also averaging longer than in *Z. f. macgillivrayi*.

Type.—No. 212,600, Amer. Mus. Nat. Hist.; ♂ ad.; Ambrym Island, New Hebrides Group; August 14, 1926; J. G. Correia.

MEASUREMENTS.—(44 males and females from all of the islands listed below): wing, 59–64 (60.9); tail, 38–42 (39.7); exposed culmen, 11.4–13 (12.5); tarsus, 18–20 (19.3) mm.

RANGE.—The entire easterly chain of islands in the New Hebrides proper, from Mai northward to Meralav; also Vanua Lava Island in the Banks Group. Specific localities are listed below.

Specimens from the following islands: Aoba, Pentacost, January, 1927; Meralav, September, 1926; Aurora, January, 1926; Ambrym, August, 1926, January, 1927; Pauuma, Lopevi, August, 1926; Epi, December, 1925, August and December, 1927; Tongoa, Tongariki, Mai, July, 1926; Vanua Lava, of the Banks Group, November, 1926.

This form exhibits evidences of intergradation with the three races already described. It averages considerably brighter on the ventral surface than *macgillivrayi*, while certain specimens show a faint yellowish tinge above the lores and on the forehead, suggestive of typical *flavifrons*.

Further evidence of its intermediate status is found in the geographic correlation of the intergrading characters; examples of *perplexa* from the southerly islands, close to Efate, are most likely to approach the subspecies *flavifrons*. However, it seems vain to try to draw a line of demarcation within the aggregation of birds under consideration. They vary widely, but apparently without essential regard to locality. They have longer tails and are generally larger than *brevicauda;* they are of brighter color than *macgillivrayi*, and yet they do not approach very closely toward *flavifrons*.

It goes against the grain to include within this assemblage the birds of the relatively remote island of Vanua Lava, in the Banks Group, especially since the nearer island of Gaua supports a well-marked endemic race. But we can find absolutely no grounds for the differentiation of the Vanua Lava specimens. They may have on the average, narrower white eye-rings, but variation in this character appears to show great independence of locality, and the Vanua Lava birds can be matched by many specimens from elsewhere.

Range in color of the breast is very wide among our fifty examples of this form, but no geographic significance is apparent. Some specimens are almost apricot yellow on the areas of greatest intensity. The state of the gonads was indiscriminately small or enlarged during all seasons represented.

Zosterops flavifrons gauensis, new subspecies

Subspecific Characters.—Resembling *Z. f. flavifrons*, but larger in all dimensions, of slightly darker coloration both dorsally and ventrally, and with a brown instead of a black bill.

Type.—No. 216,131, Amer. Mus. Nat. Hist.; ♂ ad.; Gaua Island, in the Banks Group of the New Hebrides; November 22, 1926; J. G. Correia.

Measurements.—(5 males, 4 females); wing, 61–66 (63.8); tail, 39–45 (42.7); exposed culmen, 13.5–14 (13.8); tarsus, 20–21 (20.6) mm.

Range.—Known only from the type-locality.

Specimens from Gaua, November 18–22, 1926.

In this form, which is quite unlike the Vanua Lava bird, we find a recurrence of the pattern of typical *flavifrons*, with the yellow forehead and supraloral area. The dorsal surface, however, is closer to yellowish oil green than to warbler green and the bill is distinctly brown in color, making a sharp contrast with that of specimens from Efate.

The eleven specimens collected were adults with enlarged gonads.

Zosterops flavifrons majuscula, new subspecies

Subspecific Characters.—Resembling *Z. f. macgillivrayi*, *brevicauda*, and *perplexa*, but larger than any of these, pronouncedly darker on the dorsal surface, and with a conspicuous, black infraorbital streak.

Type.—No. 212,612, Amer. Mus. Nat. Hist.; ♂ ad.; Aneiteum Island, New Hebrides Group; June 10, 1926; J. G. Correia.

Measurements.—(1 male, 1 female, respectively); wing, 62, 60; tail, 46, 44; exposed culmen, 14.5, 13.8; tarsus, 21, 20.6 mm.

Range.—Known only from the type-locality.

Two specimens from Aneiteum, June 10 and 11, 1926.

The male was a breeding adult, the female apparently immature. The measurements indicate a race of larger size than any of the other "greenish" forms of this species, to which group *majuscula* belongs. It is a black-billed bird, with a back of even darker green than that of *gauensis*. There is the slightest suggestion of yellow above the lores, but in general coloration, as well as in size, it is very different from the form inhabiting Efate. What is now needed is a comparison of adequate series of specimens from Efate, Eromanga, Tanna, and Aneiteum, for the reported relationships of the white-eyes of these islands are not what might be expected.

Flesh colors of our two Aneiteum birds are recorded as follows: iris, brown; bill, black above, white at the base of the mandible; feet and legs, dark greenish.

Zosterops tenuirostris Gould

Zosterops tenuirostris Gould, 1837, 'Synops. Birds Austr. and Adj. Isls.,' Part 1, Pl. xviii (Murrumbidgee River, error = Norfolk Island).

Nesozosterops tenuirostris Mathews, 1928, 'Birds of Norfolk and Lord Howe Islands,' p. 52, Pl. xxvii.

Measurements.—(12 males and females): wing, 64–71 (67); tail, 45–49 (46.8); exposed culmen, 14.8–15 (15); tarsus, 20–21 (20.5) mm.

Specimens from Norfolk Islands, May 25–29, 1926.

Iris, brown; bill, brown above, horny on the mandible; legs and feet "greenish" or "grayish-green." Gonads in various stages of development.

Zosterops albogularis Gould

Zosterops albogularis Gould, 1837, 'Synops. Birds Austr. and Adj. Isls.,' Part 1, Pl. xviii (Murrumbidgee River, error = Norfolk Island).

Nesozosterops albogularis, Mathews, 1928, 'Birds of Norfolk and Lord Howe Islands,' p. 51, Pl. xxvii.

Measurements.—(12 males and females): wing, 74–79 (77); tail, 51–55 (52.8); exposed culmen, 14.6–15 (14.9); tarsus, 22–23 (22.4) mm.

Specimens from Norfolk Island, May 24–29, 1926.

This species has been thoroughly described in the literature. Females, however, do not differ from males in the color of the lores, as stated by Mathews. To judge from our series, the sexes are entirely indistinguishable. The gonads were in various stages on the dates of collection, some birds being breeding. Iris, brown; bill, black; feet and legs, "grayish-green."

Aside from its large size, this species is characterized by a relatively short bill and elongate tail; the latter is two-thirds the length of the wing.

Zosterops lateralis (Latham)

It has become clear that several forms of *Zosterops* distributed among the islands to the eastward of Australia, and described under a variety of names, should be regarded as representative subspecies of Latham's *lateralis*, the type-locality of which is New South Wales.

Finsch (1901) states that this species, and presumably he meant the typical form, has extended its range by natural means from Australia to New Zealand since 1856, and that still more recently it has wandered to the Chatham Islands, five hundred miles farther eastward. Mathews (1923) goes at some length into this question, and also that of the somewhat complicated taxonomy of the species. He concludes that the bird is "eccentric" both in its wanderings and in the variability of its plumage, and that its ability to cross large tracts of water has enabled it to extend its range widely.

Our specimens of birds which are closest to Australian examples were, unfortunately, not among those sent to the British Museum for examination by the junior author. They agree substantially with published descriptions, however, and we are regarding them provisionally as the southern Australian, or typical, race.

Zosterops lateralis lateralis (Latham)

Sylvia lateralis LATHAM, 1801, 'Index Ornith.,' Suppl., p. lv, (New South Wales).

Zosterops cærulescens, SHARPE, 1884, 'Cat. Birds Brit. Mus.,' IX, p. 153.

Zosterops lateralis FINSCH, 1901, 'Tierreich,' Lief. XV, p. 39; MATHEWS, 1923, 'Birds Austral.,' XI, Part 3, p. 136.

MEASUREMENTS.—(8 males and females, 4 from each of the localities listed): wing, 60–64 (62); tail, 41–44 (42.7); exposed culmen, 10.7–11 (11); tarsus, 17–18 (17.6) mm.

Three specimens from Rangatira, or Southeast Island, and one from Round Island, Chatham Group, March 15, 1926; six specimens from Norfolk Island, March 26–29, 1926.

The Norfolk Island birds differ from the four from the Chatham Islands in having slightly more greenish yellow on the throat. The difference appears to be within the range of individual variation, however, and in other respects the birds are indistinguishable. Mathews's plate of southern Australian birds portrays a more brightly yellow throat than that of any of our specimens.

Iris, brown; bill, horny brown; legs and feet, "grayish." Gonads reduced in all specimens from either locality.

Plotted diagrams of average measurements show that these birds have relatively long wings when compared with other forms of *Zosterops* of equivalent size. Also, the outermost primary is but little shorter than the second, third, and fourth, a different condition from that found in such sedentary subspecies of *lateralis* as those inhabiting New Caledonia, the Fiji Islands, and the New Hebrides.

Zosterops lateralis flaviceps Peale

Zosterops flaviceps PEALE, 1848, 'U. S. Explor. Exped.,' VIII, p. 95 (Vanua Levu Island, Fiji Group); FINSCH, 1881, 'Rep. Voy. "Challenger,"' Zool., II, Part 8, p. 48, Pl. xiv, fig. 1.

Zosterops cærulescens var. *kandavensis* RAMSAY, 1876, Proc. Linn. Soc. N. S. Wales, I, p. 71 (Kandavu, Fiji Group).

SUBSPECIFIC CHARACTERS.—Differs from *Zosterops lateralis lateralis* in that the flanks and sides of the belly are much paler, being close to avellaneous instead of chestnut-brown; the yellow of the throat, moreover, extends farther caudad, sometimes tinging the anterior part of the breast; *flaviceps* also averages slightly larger in all dimensions except length of wing.

MEASUREMENTS.—(34 males and females, from the 27 islands listed below): wing, 57–62 (59.8); tail, 41–45 (43.4) exposed culmen, 11–12 (11.4); tarsus, 17.5–19 (18.2) mm.

RANGE.—All islands of the Fiji Group.

Specimens from 27 islands of the Fiji Archipelago, as follows:

1. Islands near the type-locality of Vanua Levu: Yendua, January, 1925; Kioa, Rambi, December, 1924; Taviuni, November, December, 1924; Namena, February, 1925.
2. The Yasawa cluster of islets, northwest of Viti Levu: Yasawa, Nathoulla, Naviti, Waia, Viwa, Yanuya, January, 1925.
3. Viti Levu and its adjacent islands: Viti Levu, June, 1924, May, 1925; Vatu Leile, November, 1924; Mbenga, Mbatika, Nairai, Ngau, February, 1925; Ovalau, Wakaya, Makongai, October, 1924; Malaki, January, 1925.
4. Kandavu and its outliers: Kandavu, November, 1924; Vuro, Vanua Kula, Yankuve, October, 1924.
5. The relatively large and isolated islands of Koro, December, 1924; Moala, July, 1924.

The Fijian white-eyes in our large series make up a very uniform aggregation. They are similar to birds from the New Hebrides, but separable by smaller size, apparently a constant character. No conclusions can be drawn from the state of the gonads, except that some birds were breeding during all of the seasons represented. A nestling taken at Kioa Island on December 5 is assuming plumage identical with that of adults.

Iris, brown; bill, light brown, horny on the mandible; feet and legs, marked "flesh," "light brown," or "gray" on various labels.

Zosterops lateralis vatensis Tristram

Zosterops vatensis TRISTRAM, 1879, Ibis, p. 444 (Vate = Efate Island, New Hebrides Group).

SUBSPECIFIC CHARACTERS.—Similar to *Z. l. flaviceps*, but uniformly larger in all dimensions.

MEASUREMENTS.—(31 males and females from all of the islands listed below): wing, 62–68 (64.7); tail, 41–49 (45.2); exposed culmen, 12.5–14 (13); tarsus, 18–20.5 (19.5) mm.

RANGE.—The New Hebrides Archipelago from Efate northward, and including the Banks and Torres Islands, with the exception of the small island of Valua in the Banks Group.

Specimens from the following 16 islands, all collected during 1926: (New Hebrides proper) Efate, June, July; Malekula, Pauuma, Lopevi, Ambrym, Malo, August; Espiritu Santo, September; Epi, August, December; (Banks Group) Meralav or Melapav, Gaua, September; Ureparapara or Bligh, November; (Torres or Vava Group) Toga or Tog or South or Puka Puka, November; Low Island, November.

Since the New Hebrides white-eyes average about eight per cent larger than those of the Fiji Islands, we have recognized Tristram's name *vatensis*. Whether or not the New Hebrides race is different from that of New Caledonia, which bears an earlier name, remains for future determination, no specimens from the latter island being yet available in the American Museum. Sharpe (1900, Ibis, p. 346) has decided in the negative on this question, but subsequent study of these insular forms has shown that comprehensive series are necessary before such conclusions can be final.

We believe, furthermore, that Tristram's statement regarding the absence of yellow on the under tail-coverts of *vatensis* is not necessarily due to the preservation of his specimens in alcohol, as assumed by Sharpe. As a matter of fact, most of our fresh birds from Efate and other islands of the New Hebrides have very pale under tail-coverts, in some cases with scarcely a trace of yellow or even buffy. That the character is not constant, however, is abundantly shown by scattered specimens from various localities in the group, including those from the Banks and Torres Islands. Our judgment is that the yellow of the under tail-coverts is subject to rapid fading after the moult.

The variations of this subspecies throughout the archipelago that extends from Efate to the Torres or Vava Islands are very interesting. Were it not for the large number of islands, and the wealth of specimens in our series, a systematist might consider that he had data for describing three or more subspecies. The variable feature is the extent and intensity of gray on the back, which seem to find their maximum at Efate, and to be somewhat reduced as we go northward through Epi, Malekula, Espiritu Santo, etc., toward the Torres Islands. The birds from the latter group have, on the average, less gray and more green on the back than those from Efate, but intergradation is so subtle, continuous, and overlapping that there seems to be no locality in which the line can be drawn. We are, therefore, treating all of these birds as a single race, with an acknowledgment that they express a certain amount of geographic variation that can hardly be indicated by sound nomenclature.

At the single small island of Valua in the north-central part of the Banks Group we find, curiously enough, a fixed variant, which is so striking in its characters that it must of necessity be recognized as a subspecies. In fact, were it not for the type of variation already described, the Valua bird might be called a species, or at least would have been so described by any ornithologist of a previous generation. In the Valua form the dorsal surface is almost entirely green, with only a suggestion of the blue-gray band across the interscapulars. This race is also buffier on the under surface than any examples of *vatensis*, whether from Efate in the south, Torres Islands at the other extreme, or intermediate localities. It also has more distinctly yellow under tail-coverts, and on the average a brighter yellow throat. The curious point is that this distinct form seems to be confined exclusively to Valua. Specimens from Meralav and Gaua, in the Banks Group, are closer to typical *vatensis* than they are to the Valua birds, while a single specimen from Ureparapara is more definitely intermediate than any of the others.

The correlation between the range of variation just described and the geographic succession of islands is very interesting, because the bluest-backed among all the birds are undoubtedly those from Efate, with a very slight increase of the green coloration toward the Torres Islands, and an abrupt change in the same direction at Valua. Both of the last-named localities are at the opposite end from Efate of an archipelago of more than thirty islands.

Flesh colors in this form agree with those of Fijian birds. Likewise the gonads seem to have been indiscriminately small or enlarged at all seasons.

Zosterops lateralis valuensis, new subspecies

Subspecific Characters.—Differs from *Z. l. vatensis* in the almost complete supression of the plumbeous gray of the back, the entire dorsal surface being warbler green save for a suggestion of green-tipped gray feathering in the interscapular region.

Type.—No. 214,063, Amer. Mus. Nat. Hist.; ♀ ad.; Valua Island, Banks Group, of the New Hebrides; September 17, 1926; R. H. Beck.

Measurements.—(6 males and females): wing, 63–65 (63.3); tail, 43–46 (44.3); exposed culmen, 13–13.5 (13.2); tarsus, 20 mm.

Range.—Apparently restricted to the small island of Valua.

Eight specimens from Valua Island, September, 1926. The subspecies has been sufficiently discussed above.

Zosterops explorator Layard

Zosterops explorator LAYARD, 1875, Proc. Zoöl. Soc. Lond., p. 29 (Kandavu Island, Fiji Group); FINSCH, 1881, 'Rep. Voy. "Challenger," Zool., II, Part 8, p. 48, Pl. xiv, fig. 2; SHARPE, 1884, 'Cat. Birds Brit. Mus.,' IX, p. 172; FINSCH, 1901, 'Tierreich,' Lief, 15. p. 13.

MEASUREMENTS.—(18 males and females, from the five islands listed below): wing, 58–63 (60.3); tail, 32–39 (35); exposed culmen, 12–13 (12.4); tarsus, 18.5–19 (18.7) mm.

RANGE.—The larger islands of the Fiji Group.

Specimens from Kandavu, November, 1924; Viti Levu, June, 1924, May, 1925; Ovalau, October, 1924; March, 1925; Vanua Levu, December, 1924, January and February, 1925; Taviuni, December, 1924.

Finsch states that this species ranges throughout the Fiji Group, but the stations on record are confined to the larger islands, and the fact that members of the Whitney Expedition did not find it at any of the smaller islets, upon which *Z. lateralis flaviceps* abounds, constitutes presumptive evidence. It is a pity that the Whitney Expedition birds from the Fijis lack notations of altitude upon their labels. The two species of *Zosterops* that resemble each other so closely may inhabit different zones, though the fact that specimens of each were taken on the same date by one collector might argue against this assumption.

Sharpe's description in the 'Catalogue' is excellent, and includes Layard's notes on the flesh colors. Our labels record: iris, brown; bill, blackish brown, horn-color at base of mandible; legs and feet, gray. Gonads large or small during all of the periods listed.

The white eye-ring is a little narrower than in *Z. l. flaviceps*, especially along the lower lid. It seems also to be continuous, while that of *flaviceps* is broken by a hiatus at the inner canthus. In both species the lower arc of the eye-ring is outlined by black feathers, but in *flaviceps* these extend forward into the lores, while the lores of *explorator* are yellow. The oustanding difference between the two species is one of proportion, *explorator* having a relatively very short tail. They are of the same general size, with wings of the same length; in *Z. exrplorator* the tail is 60 per cent as long as the wing, in *Z. l. flaviceps*, 70 per cent.

Nestlings from Kandavu, taken during November, show that the juvenal plumage is only slightly paler than that of adult birds.

Zosterops samoensis, new species

SPECIFIC CHARACTERS.—A small, greenish, plain-colored *Zosterops*, with a reduced white eye-ring and a yellow iris.

ADULTS (sexes alike).—Dorsal surface, including sides of head and lesser wing-coverts, yellowish olive, slightly lighter on the upper tail-coverts; quills of wing and tail, dorsally sooty black, the primaries, secondaries, and outer rectrices, externally edged with yellowish olive, the tertials and greater coverts more generally tinged with the same color; remiges, internally margined with whitish, except toward their tips; bend of wing, baryta yellow; lining of wing, whitish; lores, faintly tinged with yellowish; a reduced circumorbital ring of white feathers, not closely spaced; chin and anterior part of throat, barium to citron yellow, the same color in some instances appearing on the shafts of the cheek-feathers, which are otherwise but slightly yellower than the crown: remainder of ventral surface, whitish, heavily tinged with baryta yellow, yellowish olive, and, on the flanks and sides of breast, with indistinct gray and buffy tones; under tail-coverts, barium to citron yellow. Iris, light yellow (so marked on every label); bill, horny brown on the maxilla, darkest toward the tip, and yellow on the mandible; legs and feet, "grayish ' or "greenish."

TYPE.—No. 206,312, Amer. Mus. Nat. Hist.; ♀ ad.; Savaii Island, Samoa; May 23, 1924; R. H. Beck.

MEASUREMENTS.—(14 males and females): wing, 57–62 (58.6); tail, 35–38 (36.3); exposed culmen, 11–12.5 (11.9); tarsus, 16–17 (16.7) mm.

RANGE.—Known only from Savaii Island, Samoan Group.

Twenty-four specimens, collected at Savaii, May 19 and 23, 1924.

It is surprising to find at Samoa this interesting, rather obscurely colored *Zosterops*, which has been overlooked so long. The labels give no indication as to whether the species is generally distributed or whether it is confined to the mountains of Savaii, which are well over five thousand feet in altitude.

Perhaps the most interesting feature of *Zosterops samoensis* is the fact that it has a "light yellow" iris, most or all of the other Pacific species having brown eyes.

Compared with *Z. explorator*, *Z. flavifrons*, and the races of *Z. lateralis*, it is characterized by a short tarsus. With the exception of the color of the iris, the shortness of the tarsus, and much smaller size, *Z. samoensis* bears an extraordinary resemblance to *Z. sanctæ-crucis* of the Santa Cruz Group.

Many of our specimens were in breeding condition when collected.

Zosterops sanctæ-crucis Tristram

Zosterops sanctæ-crucis TRISTRAM, 1894, Ibis, p. 31 (Santa Cruz Island, Santa Cruz Group); FINSCH, 1901, 'Tierreich,' Lief. 15, p. 42.

MEASUREMENTS.—(6 males, 5 females): wing, 65–72 (68); tail, 39–43.5 (41); exposed culmen, 13–13.8 (13.3); tarsus, 21–22 (21.7) mm.

RANGE.—Known only from Santa Cruz (Ndendi, Nitendi, or Egmont) Island.

Twenty-two specimens, Santa Cruz, October, 1926, February, 1927.

This hitherto little-known species bears an astonishing resemblance to the bird we have just described as *Zosterops samoensis*. The single islands inhabited by the respective forms are twelve or thirteen hundred miles apart, but, were it not for a marked difference in the proportional length of the tarsus, it would be natural to regard the two as representative races of one species. When graphs of the dimensions are juxtaposed, however, *sanctæ-crucis* is shown to have a relatively much longer tarsus and relatively shorter bill.

Z. sanctæ-crucis is about 17 per cent larger than *Z. samoensis*, as reckoned from average lengths of wing. It is definitely of lighter hue on the dorsal surface, though both birds show the same peculiar glaucous tone on their olive plumage. Ventrally, *sanctæ-crucis* is more evenly yellow than *samoensis;* in other respects they are much alike, even to such subtle details as the marginal coloration of the quills. The white eye-ring, almost vestigial in *samoensis*, has retrograded still further in *sanctæ-crucis*, and has, in fact, been practically replaced by dusky feathers that fill the lores and completely surround the orbital region. This feature, and the brown iris, supply a distinct contrast with *samoensis.*

Tristram called attention to the striped appearance of the pileum, evident in many of our specimens and due to exceedingly faint yellowish shaft-markings.

The gonads were either small or enlarged among birds taken during both periods represented. Iris, brown; bill, black, but basally whitish on the mandible; feet and legs, "bluish."

SANFORDIA, new genus

Extremely long-billed Zosteropidæ, the exposed culmen being more than 80 per cent of the length of the tarsus and approximately 25 per cent of that of the wing. Resembling the genus *Woodfordia*, but with feathered lores and circumorbital region, a longer and slightly more compressed bill, and narial opercula similar to those of typical *Zosterops*. The type species is *Sanfordia lacertosa.*

Sanfordia lacertosa, new species

SPECIFIC CHARACTERS.—An extremely large, nearly unicolor, exceedingly long-billed species, with feet and legs relatively as well as absolutely stouter than is usual in the family. It superficially resembles *Woodfordia superciliosa* but is larger, in addition to the differences noted above. In coloration it is apparently not unlike *Zosterops finschi* (Hartlaub), of the Pelew Islands. From other large Pacific Zosteropidæ, such as *Z. albogularis*, it differs in having a relatively much shorter tail, as well as heavier legs and feet, and the strikingly elongate bill.

ADULTS (sexes alike).—Dorsal surface, mainly Saccardo's umber, blending into sepia on the pileum and reddening to Prout's brown on the upper tail-coverts, the whole, however, tinged with a faint suggestion of greenish or olivaceous, making a hue that cannot be matched exactly in Ridgway's 'Color Standards'; lighter feather-shafts on the crown produce a faintly streaked effect; at the base of the nostrils and across the anterior border of the forehead are a few antrorse, buffy feathers, distinctly lighter than those of crown and back; quills of wing and tail, blackish brown (1), with a definitely reddish bloom, and externally margined with tawny, most conspicuously on the middle primaries and the secondaries; wing-coverts, like remiges, but with tawny borders only on the distal row; quill shafts, white in ventral aspect; the same surface of the quills, mouse gray, with reddish reflections; lining of wing mainly mouse gray, but with a few ochraceous feathers along the bend; lores and circumorbital region, dirty whitish, most pronounced above the eye where it forms a faint suggestion of a superciliary stripe which blends with the indistinct light color of the lores and narial plumage; an obsolete eye-ring of silky, grayish rather than white, feathers; cheeks, slightly lighter than the dorsal plumage, owing chiefly to the presence of indistinct whitish feather-shafts, which extend forward beneath the eye to the bill, and to a lesser extent across the throat; entire ventral surface, generally cinnamon-buff to clay color, more rufous on the flanks and under tail-coverts, but with an indistinct olivaceous wash on the throat and breast, and frequently with a grayish mottling at points where the concealed plumbeous portions of the feathers appear at or near the surface. Iris, brown; bill, "straw color" (whitish or ivory in the dried specimens); feet and legs, "straw color" or "light yellow."

TYPE.—No. 222,157, Amer. Mus. Nat. Hist.; ♂ ad.; Santa Cruz Island, Santa Cruz Group; February 26, 1927; R. H. Beck.

MEASUREMENTS.—(17 males and females): wing, 79–86 (83.1); tail, 46–53 (49); exposed culmen, 20–22 (21); tarsus, 24.5–25.6 (25) mm.

RANGE.—Known only from Santa Cruz (Ndendi, Nitendi, or Egmont) Island.

Eight males, nine females, Santa Cruz Island, February 23–27, 1927.

The wealth of the South Sea Islands is again indicated by the discovery of a second endemic representative of the Zosteropidæ on a body of land not more than fifteen miles in length. *Sanfordia lacertosa* is a very striking bird, with its elongate bill, entirely light in color except for the dark narial opercula. The bill is distally more attenuate than that of *Woodfordia*, and slightly less decurved, both showing the characteristic subterminal notch on the maxilla. *Woodfordia* is in effect a "green" bird, *Sanfordia* a "brown" bird, but one can not escape a feeling that their relationship is not remote. The characters upon which the genus *Woodfordia* were based forbid congeneric treatment of the Santa Cruz species. On the other hand, the disproportionately long bill of *lacertosa* makes it out of place in the genus *Zosterops*, in addition to which the long and heavy legs and feet are very distinctive.

The gonads were in various stages on the dates of capture, some specimens being marked as breeding.

AMERICAN MUSEUM NOVITATES

Number 358 Published by
The American Museum of Natural History
New York City July 10, 1929

59.9,74 M (51)

MUSTELIDS FROM THE ASIATIC EXPEDITIONS[1]

By Glover M. Allen

On bringing together the mustelids, collected by the Asiatic Expeditions, they are found to comprise over one hundred and forty skins, representing various localities in China (chiefly in Yunnan, Szechwan, and Fukien Provinces) and a few in Mongolia. A critical study of these has entailed a careful consideration of a number of names based on eastern Asiatic specimens, with the result that in many cases it has been possible to arrive at fairly satisfactory conclusions as to their validity. A few wide-ranging species have closely allied representatives in northern India and in parts of China, as *Mustela sibirica*, *M. kathiah*, and *Arctonyx collaris*, so that it will be necessary eventually to show the relationship of sundry Chinese forms to Himalayan species by the use of trinomials. A list of the species secured, with brief remarks, follows. Only one new form is described, a northern race of the lesser ferret-badger, a species hitherto known only from Indo-China.

Charronia flavigula flavigula (Boddaert)

Mustela flavigula Boddaert, 1785, 'Elench. Anim.,' p. 88.

Size of a house cat, with long tail and short legs; head from muzzle to base of ears, the nape, forearms, fore feet, hind legs and tail brownish black; body above golden on shoulders, passing into brown and black on rump; chin to ears white, throat yellow, belly brownish gray; in summer darker above and below on body.

The series of this long-tailed marten includes four from the Namting River, Yunnan, near the Burma border, and one from Lichiang in the same province, that undoubtedly represent the typical form, whose range extends southeastward at least to Siam, for Thomas has lately relegated the name *indochinensis*, based on the Siamese animal, to the synonymy of *flavigula*. There is more or less individual variation in color among these specimens and the matter is further complicated by the fact that summer skins are darker than winter specimens, apparently with an increase in the golden area of the back and a darkening of the belly. It was a dark-bellied skin (May 6), no doubt wholly or partly in summer fur, that served Bonhote as the type of his *Mustela f. kuatunensis* from Fukien, but this supposed race also proves to be untenable, for winter skins from this province are quite as pale-bellied as those from Yunnan taken in February. Indeed, the yellow of the throat seems a very little paler in winter skins from Fukien as compared with the latter, but this difference is so very slight and uncorrelated with other characters, that it seems better to regard the South China form as typical *flavigula*.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 89.

A single skin from the Tsingling Range, Shensi, is a trifle paler yellow on the throat and lighter brownish gray above than any of the more southern winter skins but this variation may be individual, or possibly approaches the winter condition of *C. f. borealis* (Radde) of Amur Land, a race that seems to be slightly paler and with a very little larger skull. To this subspecies Jacobi referred the skins from Min Valley region, Szechwan, brought back by the Weigold Expedition and showed that Hilzheimer's *Mustela f. szetschuensis* is not distinguishable. Additional material from northwestern Szechwan, however, shows no important differences from the Yunnan series and is probably best regarded as *C. f. flavigula*. The range of *C. f. borealis* is probably cut off from that of the Chinese animal by the intervention of the Gobi Desert, except in northeastern China and Manchuria.

Mustela larvata tiarata Hollister

Mustela tiarata Hollister, 1913, Proc. Biol. Soc. Washington, XXVI, p. 20.

A large weasel, face and forehead dark brown, neck, back, and basal two-thirds of tail light fulvous, with short white underfur, the back darkened by long black-tipped hairs; throat, chest, fore and hind legs, and tip of tail blackish to blackish brown; sides of belly buff.

The weasel described by Hollister from Kansu (150 miles east of Lanchow) as *Mustela tiarata* is undoubtedly a very close relative of *M. larvata* of southern Tibet, from which it differs mainly in having the blackish facial mask continuous with the dark brown of the forehead instead of being separated by a distinct white area, and in having the terminal part only of the tail black instead of its entire length. Apparently Hollister's *M. lineiventer* from the Little Altai is a paler race with the facial mask distinct, while the animal described by Kastchenko from northwestern Mongolia as *michnoi*, is, as Hollister suggests, probably a race of *eversmanni* rather than of *larvata*, so far as may be judged from the description. The latter is at once separated from *eversmanni* by its larger size, its tail longer in proportion, with a shorter black tip, and by its more yellowish ground color. In Hollister's description of *M. tiarata* the length of the foot is given as 93 mm., evidently a misprint for 63; also the tail of the type is said to have its terminal two-thirds black.

The Asiatic Expeditions secured three skins, from a locality eighty miles southeast of Urga, that conform closely with the description of *tiarata* except that the black tail-tip varies in length in each, from nearly one-half to a third, and even a quarter of the length of the tail. A fourth skin, from Paotou, Shansi, taken in spring is apparently paler on the body and with the forehead and crown as well as the sides of the face white instead of brown, and the nape nearly clear white with a yellow wash, indicating a seasonal difference in the coloring of the head and body. This weasel, like our black-footed ferret, frequents the colonies of marmots and ground squirrels on which it preys.

Mustela sibirica fontanieri (A. Milne-Edwards)

Putorius fontanierii A. MILNE-EDWARDS, 1868–74, 'Recherches Hist. Nat. des Mamm.,' p. 205, Pl. LXI, fig. 1.

Weasel-like, with a long rather bushy tail, three-fifths the length of head and body; color uniform pale fulvous, slightly paler below; forehead brown, chin white, with often white marks on throat.

A careful comparison of Milne-Edwards's description and figure of *Putorius fontanierii*, based on a skin without skull from Peking, leaves no doubt that this animal is a representative of the yellow mink of Siberia and China. The description applies well to a female in pale winter pelage, and the dimensions taken from a skin are nearly identical with those of a female from Shansi. The yellow mink of eastern China has been currently referred to *M. sibirica* of Pallas, whose specimens came from the forests of Siberia, "voisines de l'Enisséi," but it seems unlikely that it is subspecifically the same as the more northern animal, especially in view of Radde's statement (1862, 'Reise,' I, p. 45) that specimens from the Amur region are larger and darker than those of the Baikal district. Until topotypes of *sibirica* are avilable for comparison therefore, Milne-Edwards's name may be adopted for the very pale-yellow form of the dry area of North China. In fresh winter pelage, the body is very pale, about "pinkish cinnamon" (Ridgway, 1912) above, paling to "cinnamon-buff" below, the tail somewhat more intensely colored, about "orange-cinnamon" (specimen from Fengsiangfu, Shensi, November 23), while late-winter specimens are even paler. The collections include skins from Chimo (Shantung Province), Kweihuacheng (Shansi Province), and Fengsiangfu (Shensi Province). There are also two adult males in the Museum of Comparative Zoölogy from near Taiyuanfu, Shansi.

Mustela sibirica davidana (A. Milne-Edwards)

Putorius davidanus A. Milne-Edwards, 1870, Nouv. Arch. Mus. d'Hist. Nat., Paris, VII, Bull., p. 92.

The yellow mink of southeastern China is much more intensely colored than that of northern China, almost "ochraceous-orange" (Ridgway, 1912) in fresh winter pelage, and tail not differing from the back. Summer specimens are darker, almost "ochraceous-tawny." Milne-Edwards's name *davidana,* based on a female from Kiang-si Province, is available for this form, the range of which extends from Shanghai west nearly to the borders of Szechwan and south in Fukien Province to Amoy, where Swinhoe mentions it as frequenting the walls of houses in pursuit of rats. The collections of the Asiatic Expeditions include skins from Foochow and Futsing (Fukien Province) and Ching River (Hupeh Province), while the Museum of Comparative Zoölogy has skins from Soochow (Kiang-su Province) and Ichang (Hupeh Province).

Mustela sibirica moupinensis (A. Milne-Edwards)

Putorius moupinensis A. Milne-Edwards, 1870, Nouv. Arch. Mus. d'Hist. Nat., Paris, VII, Bull., p. 92.

In the highlands of western China this species is represented by a much darker form having a contrastingly dark tail-tip. The brownish of the forehead extends back along the median part of the back, which in the other races mentioned is pale. The dark tip to the tail is present in all the skins examined, which includes six from Wanhsien, two from Tachiao, and one from Washan, in Szechwan, and one each from Talifu and Lichiang in Yunnan. The last locality is at an altitude of 12,000 feet.

Milne-Edwards, in describing these forms, gave them all specific status and apparently did not recognize the fact that females are considerably smaller than males. The westward range of this race probably is continuous with that of the smaller Nepalese *sub-hemachalana,* which may eventually prove also to be a subspecies of *M. sibirica.* Thomas indicates further that his *M. hamptoni* from Mt. Imaw Bum, northern Burma, is closely related to *moupinensis,* if not identical with it.

Mustela kathiah Hodgson

Mustela (Putorius) kathiah Hodgson, 1835, Journ. Asiatic Soc. Bengal, IV, p. 702.

A weasel with tail slightly more than one-half the length of head and body; dorsal surfaces and tail all around uniform dark brown; lips and chin white; throat to wrists and ankles bright yellow, sharply delimited at sides.

A series of eleven weasels from Yenping and Futsing, Fukien Province, evidently represents Matschie's *Arctogale melli*, described from the adjoining province of Kwangtung, but I cannot see that they differ in any way from *M. kathiah*, of Nepal, to which the yellow-bellied weasel of Szechwan is currently referred. A single immature specimen from Lichiang, Yunnan Province, 9000 feet, is quite the same, so that, as in the case of *Charronia flavigula*, this weasel seems to have a wide range from northern India across southern China, without important change in color or size. There seems to be no doubt that Milne-Edwards's *Putorius astutus*, based on a weasel of this group from Moupin, Szechwan, is identical with the species here considered. He mentions that its fore feet are white on their upper surface, but this is not true of the Yunnan specimen, nor apparently of Nepalese specimens, though Hodgson mentions one from western India that had partly whitish feet. Matschie makes the wholly dark feet of his Kwantung specimen the chief distinctive character of *Arctogale melli*, but this is probably a matter that may vary individually. Yet none of the Fukien series has any white on the feet. Trouessart, describing a skin from Fukien, collected in 1874 by David, likewise states that the feet are dark like the back, while of three others from Ta-tsien-lu, Szechwan, supposed to be winter specimens, two have white toes and the third only "un peu de jaune" on the external side of the feet. Thus, while Szechwan specimens may or may not have white feet, it seems that those from Nepal, Yunnan, and Fukien do not so far as available evidence goes. Farther north, however, white on the feet is apparently the usual condition.

As to seasonal variation, the Fukien series is about equally divided between summer and winter skins, yet there is very little difference between those of July and those of December. The latter are, however, a very little paler above, more buffy, especially the underfur. The intensity of the yellow on the lower side varies individually from buff to deep ochraceous.

Mustela pygmæa (J. A. Allen)

Putorius (*Arctogale*) *pygmæus* J. A. Allen, 1903, Bull. Amer. Mus. Nat. Hist., XIX, p. 176.

Very small, tail about as long as hind foot; above, including tail, brown; below white, including upper lip, fore feet (except center of backs of hands), the inner side of hind legs, and terminal half of hind foot.

Three summer skins taken in the vicinity of Urga, Mongolia, agree perfectly with the original description of this species, the type of which came from Gichiga, on the Okhotsk Sea, Siberia. One, a male, is from 15 miles north of Urga, the second is from 45 miles northeast of that city, while the third, a female, is without precise locality. This, is therefore, a considerable extension of the known range to the southwestward. Kuroda, in 1921, announced the discovery of a weasel of this type from northern Hondo, Japan, and named it *Mustela rixosa namiyei.* The female of the three Mongolian specimens has four small brown spots medially on the chest. One, a male, measured: total length, 177 mm.; tail, 20; hind foot, 24; ear, 16; the female, total length, 158; tail, 17; hind foot [? 20]; ear, 10. No doubt the relationship of this weasel to the American *M. rixosa* is very close.

HELICTIS Gray

Ferret-badgers

The ferret-badgers are distinguished externally by their somewhat weasel-like form, though they are less slender, their strong fore claws, greatly developed cartilaginous snout, and their color which is brownish gray above, more or less hoary, white below, and with white facial markings on forehead, cheeks, and ears, often with more or less of a white median line extending from the nape spot to the shoulders. They are of special interest since the several species of eastern Asia are very much alike externally but are very different in cranial characters. Thomas (1922) has lately summarized these points and recognizes three genera for the Indian, Chinese, and North Bornean ferret-badgers, but in view of the quantitative nature of the characters it may be better to regard these divisions as of subgeneric value only, for the species are obviously nearly allied. The Indian *Helictis personata* represents then the subgenus *Melogale,* distinguished by its heavy teeth, the lower second premolar disproportionately larger than the first, and the upper carnassial with its external edge convex instead of practically straight. A smaller race occurs in Tonkin, and probably will be found to reach the southern borders of Yunnan, *Helictis (Melogale) personata tonquinia;* another small-toothed subspecies *H. (M.) personata laotum,* is named from northeastern Siam. This subgenus is further distinguished from typical *Helictis* (type *H. moschata*), by the characters of the baculum or penis bone, which, as Thomas points out, is bifid terminally, with the prongs thickened, one forming a curved crest, whereas in *H. moschata* the tip is trifid, with the slightly thickened terminal prongs set in a triangle. There is evidence that this difference is not so trenchant as might appear, for in a baculum of *H. (M.) p. tonquinia* in the Museum of Comparative Zoölogy there is, in addition to the two large thickened lateral prongs, a small ventral knob representing the third one, that is more fully developed in *H. moschata.* An additional peculiarity of *Melogale,* not mentioned by Thomas, appears very clearly on laying out the series of skulls available, namely, the very different character of the temporal ridges. In *Melogale,* these are heavier and more nearly median, curving strongly inward from the supraorbital processes so that their point of closest approximation is about the diameter of the orbit behind these processes, and from there back the ridges diverge very slightly. In *Helictis* as represented by the *moschata* group, the ridges are less heavy, much wider apart, and either parallel or slightly bowed outward over the braincase, occasionally converging at their posterior ends.

The close similarity of these two species makes it seem likely that their geographic ranges are mutually exclusive or nearly so. Anderson (Zool. Res. Yunnan) long ago recorded *H. moschata* from western Yunnan, but the specimen is possibly referable to the animal Thomas named *millsi* of Assam, no doubt to be regarded as the westernmost race of *H. moschata.* A further interesting point is the occurrence of a smaller species, *H. taxilla* Thomas, closely resembling *H. moschata* but of very much less size. Originally discovered in Tonkin, French Indo-China, the collections made by Mr. Clifford H. Pope for The American Museum of Natural History have resulted in extending its known distributon to Fukien Province, a thousand miles to the northeast, where it is represented by the large-toothed race described below.

Helictis moschata Gray

Helictis moschata Gray, 1831, Proc. Zool. Soc. London, I, p. 94.

The type locality is Canton, Kwangtung Province, South China, where the original specimen was secured by John Reeves. A series of 17 skins and skulls, secured by Mr. C. H. Pope in Hainan, is provisionally referred to the typical race in the lack of specimens from elsewhere in South China for comparison. Dr. J. A. Allen, in his list of the mammals of Hainan, follows the same course.

Helictis moschata ferreo-grisea Hilzheimer

Helictis ferreo-griseus Hilzheimer, 1905, Zoöl. Anz., XXIX, p. 298.

The type is a skin purchased in Hankau, Hupeh Province, and no doubt came from that general region. If the Hainan skins are correctly referred to typical *H. moschata,* those from Fukien and eastern Szechwan represent a larger race with grayer tone to the pelage, for which Hilzheimer's name is available. The average measurements of a series of skulls show that the northern animal is larger by several millimeters in most of its dimensions and the color is usually without the buffy tint to the white under parts and pale bases of the hairs above, though occasional specimens agree with the more southern animal in the pale orange suffusion of the lighter areas. Males average a very little larger in cranial dimensions than females. Specimens were secured at Futsing, Yenping, and Chunganhsien in Fukien Province, and at Wanhsien in eastern Szechwan, and Yochow, Hunan.

Helictis taxilla sorella, new subspecies

Type.—Adult male, skin and skull, No. 85030, American Museum of Natural History, from Futsing, Fukien, China. February 21, 1926. Clifford H. Pope, collector; Third Asiatic Expedition.

Description.—Externally similar to *H. moschata* in general appearance, but much smaller, the ears slightly larger in proportion, the claws of the fore feet slightly more curved, the metatarsal pads shorter; the skull is relatively more slender, less inflated, and with a narrower muzzle. From typical *H. taxilla* of northern Tonkin this Chinese race is distinguishable by its smaller skull in combination with the large size of the teeth, which are even slightly larger than in *taxilla.*

Color, pale chocolate-brown above, becoming hoary on the sides; tail long-haired and narrow, the chocolate hairs predominating on the basal half, the white-tipped ones on the distal portion. The pelage above has the proximal part of the hairs dull whitish. Notwithstanding that the white and dark head-markings are "about as in *moschata*" (Thomas) the four specimens from Fukien differ from that species in the following points: the white interorbital spot tends to be more linear than broad (in one it extends from nose-pad to crown as a broad line); the cheeks behind the eye are grizzled chocolate-gray and whitish, whereas in *moschata* a distinct dark spot extends backward from the posterior corner of the eye and is surrounded above and below by an area of clear white; finally a third distinctive mark of *moschata* is the presence of a small elongate chocolate spot beginning about 5 mm. behind the angle of the mouth and embracing a small clump of dark vibrissæ, but in the four specimens of the smaller species this spot is without exception absent and the corresponding vibrissæ are white or poorly developed. The ventral surface of the body, including the fore legs to the wrist and the hind legs nearly to the ankles, is dull white. Inside of ears and their outer rim whitish.

Skull.—This is a replica on a smaller scale of the skull of *H. moschata* but, as Thomas has pointed out in his description of *H. taxilla,* it is more slender, especially in the rostral part, with a low and less inflated braincase. The female, however, seems to have a slightly more inflated skull than the male. The temporal ridges are wide apart and nearly parallel. The tooth rows are very nearly as long as in *H. moschata* and slightly longer than in *H. taxilla*, but the individual teeth are as large as in the former species, resulting in a more slender attenuate rostrum for their accommodation. The distance between the upper molars equals the width of the postpalatal tube whereas in the larger *H. moschata* it exceeds that width.

MEASUREMENTS.—The collector's measurements of the type and a female topotype are respectively: head and body, 330, 320 mm.; tail, 140, 150; hind foot, 40, 40. In the dried skin the hind foot without claws measures in each 45 mm.

The skull of the type measures: greatest length, 71 mm.; basal length, 63.8; palatal length, 33.6; orbit to tip of rostrum, 24.8; zygomatic width, 37.0; mastoid width, 30.2; width across outer corners of molars, 18.2; interorbital width, 16.3; depth of braincase including bulla, 25.2; upper cheek teeth, 23.0; lower cheek teeth (canine to molars inclusive), 27.0.

This smaller species bears so close an external resemblance to *H. moschata*, that it may easily be confused with it. A close examination, however, shows that in addition to its smaller proportions, it differs in the gray instead of white cheek markings, the lack of a rictal dark spot, the much shorter metatarsal pads, and the weaker and slightly curved instead of nearly straight fore claws. In the case of two species so alike in structure living in the same region, one suspects a difference in habits, and it may be that the last two points indicate modifications for tree-climbing instead of terrestrial life.

Meles meles leptorynchus Milne-Edwards

Meles leptorynchus MILNE-EDWARDS, 1867, Ann. des Sci. Nat., Zool., (5) VIII, p. 374.

A badger with the under side from chin to root of tail and the feet blackish to blackish brown. A white stripe from the angle of the mouth on each side to and beyond the base of the ear, and a median one from muzzle to eyes or occiput, as well as a blackish stripe from muzzle including the eye; all merge at the back of the head in the grizzled black and buffy white of the rest of the dorsal side.

The black instead of white throat and the white instead of grizzled tail distinguish skins of this genus at a glance from those of *Arctonyx*. Compared with the European badger, the Chinese form has the white facial stripes shorter and the pale tips of the hairs above are less extensive and tinged with buffy instead of being pure white. The median white stripe on the muzzle is usually clear and broad to or slightly past the level of the eyes, beyond which it becomes smoky brown or even heavily brown, but in one of eleven skins is darkened quite to the nasal pad. Matschie's *M. tsingtauensis* is based on a nearly normal specimen with the stripe extending to the eyes. Matschie's *M. hanensis* and *M. siningensis* are also synonyms, based on slight individual variations in color.

The relationship of the Chinese badger to the European *M. meles* seems, on examination of a series of both, to be not more than subspecific. The color pattern is the same, except that the white head-markings are more obscured in the former, and its general tone is a little more buffy The European animal is distinctly larger of skull with a better developed median crest. It also may occasionally have the first upper and first lower premolar (p^1 and p_1) present as small spicules but more often the upper one is altogether lacking and the lower one frequently, while in old age both are deciduous. In the Chinese badger, on the other hand, there seems to be no indication that the first small premolar is ever present, for in all the specimens at hand there is not even a space where it might stand in the toothrow. The slightly greater inflation of the bullæ is noticeable in Asiatic specimens, even in those of Asia Minor, which thus afford an intermediate condition.

Arctonyx collaris collaris F. Cuvier

Arctonyx collaris F. Cuvier, 1825, 'Hist. Nat. des Mamm.,' pt. 51 (2 pp., Pl.).

A large, short-limbed badger, with pale claws; a white forehead stripe, and a shorter one below the eye; throat, ears, and tail white; feet and belly black. The fur of the back is basally white with a black terminal portion, or the black band may be succeeded by a white or a yellowish tip, so that specimens from the same locality may be black-backed or largely grizzled gray, often with a yellowish tinge.

The precise relationships of the Asiatic hog-badgers still require to be more carefully worked out with adequate material. The collections of the Asiatic Expeditions include fourteen skins and eight skulls from various localities in China and these show a considerable amount of variation which seems individual rather than geographic. Skins from the same region vary in color from those having white head-markings and black nape and back (with white bases to the hairs) to those with the facial markings tinged with ochraceous, the nape, shoulders, and all the hairs of the back white-tipped or ochraceous-tipped. A light-colored specimen of the latter type served as the basis for Thomas's *A. leucolæmus orestes* from the Tsingling Mts., Shensi. I cannot see that specimens occurring from Yunnan across South China to Fukien differ materially from *A. collaris* of Bhutan, judging from descriptions of the latter, and allowing for certain inaccuracies in the original figure as to the thinly haired tail. Anderson, who examined the type of *A. obscurus* from western China, regarded it as a young animal identical with *A. albogularis*, itself doubtless the same as *A. collaris*, and Milne-Edwards also admits the close similarity. Wroughton in his summary list of Indian mammals (1919, Journ. Bombay Nat. Hist. Soc., XXVI, p. 347) states that the greatest length of skull in *A. collaris* is 135 mm., which is almost precisely that of adult skulls from Fukien (condylobasal length 135.7–136 mm.). Thomas, in 1922, described as *A. obscurus incultus* an old male from Anhwei, which differs in its thin coat and the great inflation of the sides of the posterior tubular part of the palate. The former character, however, is likely to vary seasonally as it obviously does in the Fukien and Yunnan skins, while the degree of inflation of the palate varies considerably in skulls from the same locality in Fukien. I am, therefore, regarding all the specimens in the present series from Lichiang, Yunnan Province, and from Chungan, Yenping, and Futsing, Fukien Province, as *A. collaris collaris*.

Arctonyx collaris leucolæmus (A. Milne-Edwards)

Meles leucolæmus A. MILNE-EDWARDS, 1867, Ann. des Sci. Nat., Zool., (5) VIII, p. 374.

Smaller than the typical form, skull with condylobasal length of 123 mm., the white collar usually complete; the dark color of the back extending on to the basal part of the tail.

Three skins labelled from Chihli Province represent this slightly smaller subspecies. In Milne-Edwards's figure of the type from the environs of Peking, the white collar extends broadly across the nape, passing gradually into the grizzled, white-tipped hairs of the back. The three skins above noted show this collar but the entire back is black, lacking the white-tipped hairs. The skulls of two of these (labelled males) are aged and considerably smaller than those of South China animals, with the posterior tubular part of the palate hardly inflated at all. They agree in small size with the type skull as figured by Milne-Edwards. The third skin is not accompanied by a skull. In 1923, Lönnberg (Ann. Mag. Nat. Hist., (8) XI, p. 322) described as *A. leucolæmus milne-edwardsii* a hog-badger from the Minshan, southern Kansu, the chief characters of which are the black instead of grizzled dorsal surfaces, and the presence of a minute premolar (p^1 and p_1) in both jaws. He calls attention to a similar tooth variation in a specimen from Shensi recorded by Milne-Edwards. The skull of the type, a subadult female, is small, like that of Chihli specimens (123 mm. long), while the material now at hand shows that the variations in color and in the presence or absence of the minute anterior premolars are altogether individual, for the skins from Chihli are similar in their black backs to that from Kansu, while of two skulls from Chihli, one has p_1 in the left lower jaw; and in six others from South China representing *A. c. collaris*, two have p^1 present in the left upper jaw, and all have p_1 on both sides in the lower jaws. It is obvious that this small tooth is in process of disappearance, and so is either quite absent or represented by a minute spicule, of varying size. The Minshan hog-badger is thus similar to that of Chihli and both seem to represent the slightly smaller, white-naped race, *A. collaris*, described by Milne-Edwards.

Lutra lutra chinensis Gray

Lutra chinensis Gray, 1837, Mag. Nat. Hist., (2) I, p. 580.

A clawed otter with the upper outline of the naked nose-pad W-shaped, instead of nearly straight across; general color light chocolate-brown, lips white, longer hairs of the lower surface white, the under-fur pale brown, whitish at base.

Two otter skins, one from Nodoa, Hainan, the other from Yenping, Fukien Province, are quite similar in color and evidently represent Gray's *L. chinensis*, the type of which was sent from China by Reeves, hence probably from near Canton. They are decidedly paler than European and Japanese skins of *Lutra lutra* and probably somewhat smaller, although the skulls indicate that the animals are hardly more than adult. The upper border of the nose-pad is W-shaped, with a decided central triangular point, as in the *L. lutra* group. It is probable that Matschie's *Lutra hanensis*, based on a trade-skin purchased in Hinganfu, southern Shensi, may represent the Indian and Burmese species, *tarayensis*, in which the outline of the nose-pad is nearly straight above as he describes it.

AMERICAN MUSEUM NOVITATES

Number 359
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
July 15, 1929

59.9,74 V (51)

VIVERRIDS FROM THE ASIATIC EXPEDITIONS[1]

BY GLOVER M. ALLEN

The Viverridæ, or civets and their allies, is a family characteristic of tropical and subtropical climates where it largely takes the place of the Mustelidæ or weasels, although a few species extend northward into warm-temperate regions. The collections made by the Asiatic Expeditions, under the direction of Dr. Roy Chapman Andrews, include over two hundred skins, mostly accompanied by skulls, from South China, particularly from Hainan, Fukien, and Yunnan Provinces. Although these seem referable to but six species, the series of each is in most cases so large as to give an adequate idea of the range of individual, sexual, and geographical variation and to allow a fair estimate of the validity of sundry names bestowed in recent years upon certain Chinese specimens. Although no new forms were recognized it has seemed worth while to list the species taken, with critical notes on each.

Viverra zibetha Linnæus

Viverra zibetha LINNÆUS, 1766, 'Syst. Nat.,' 12th Ed., I, p. 65; Bengal (see Thomas, 1911, Proc. Zoöl. Soc. London, p. 137).

The collection contains a magnificent series of over fifty civet skins, chiefly from Fukien and Szechwan, and includes five from western Yunnan (Lichiang, and Namting River); but in the absence of specimens from India they are all referred provisionally to the typical race, notwithstanding that several subspecific names have been proposed on the basis of one or several skins each. Thus, in 1864, Swinhoe described as *Viverra ashtoni* a specimen from Min River, Fukien Province, which lacked obvious cross-bands on the haunches and had the black dorsal stripe continued to the third dark tail-ring instead of ending (as commonly) with the first. Matschie, in 1908, renamed the Chinese civet *V. filchneri* on the basis of skins secured at Hinganfu, southeastern Shensi, claiming as distinctive characters the presence of wavy cross-bands on the haunches, six instead of five broader black and six narrower white tail-rings unconnected with one another dorsally (except that the basal dark ring is united medially with the dorsal stripe), a black tail-tip, a pronounced broadening of the middle dark neck-band, and smoke-gray underfur. More recently, Wroughton (1915, Journ. Bombay Nat. Hist. Soc., XXIV, p. 64) gave subspecific names to two supposed Indian races, *picta* from the Upper Chindwin River, Burma, and *pruinosa* from Little Tenasserim River, Burma. He later (1918, idem, XXVI, p. 46) regarded the former as untenable, but distinguished the latter race by its clear gray without a general yellow tinge to the ground color. Robinson and Kloss have since (1920, Rec. Indian Mus., XIX, pt. 4, p. 176) added another supposed race, *sagillata*, from peninsular Siam, differing in the sharper definition of its markings. Wroughton adds that one of his specimens from Upper Chindwin River is exactly like a skin in the British Museum from Shensi, while Robinson and Kloss maintain that specimens from Tenasserim are invariably more yellow than true *zibetha* instead of grayer as Wroughton claimed.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 90.

The present excellent series secured by the Asiatic Expeditions indicates that in all the characters mentioned there is considerable variation. In skins from the same locality, the usual buffy ground-color of the body may be replaced by clear gray—a mixture of white-tipped and blackish hairs; the pattern on the flanks may be extremely indistinct with every gradation to inobvious spots and blotches and even indistinct cross-stripes that become well defined on the rump. The number of rings on the tail is usually twelve, six white and six black, the terminal one black, but it may be five of each, while one from Yenping, Fukien, had no less than eight of each, the last three black ones very close together and separated by very narrow white rings. Usually only the basal black ring is connected dorsally by an extension of the median stripe of the body, but occasionally this may continue to the second or third and even beyond, showing as a few scattered black-tipped hairs. In specimens with a well-developed yellowish tint, it is usual to have the basal one or two black tail-rings provided with a pair of ochraceous centers, separated by the black median stripe. In one exceptionally bright skin from Fukien these centers are rusty in color and are indicated as scattered hairs of that hue on the third black ring. A single female skull from Hainan is slightly smaller in its dimensions than Fukien specimens.

It is obvious that all the characters hitherto used in the attempt to discriminate local races of the civet are subject to wide individual variation, and since there seem to be no striking differences in cranial measurements, I refer all Chinese examples to the typical form.

Viverricula malaccensis malaccensis (Gmelin)

Viverra malaccensis GMELIN, 1788, Linnæus's 'Syst. Nat.,' 13th Ed., I, pt. 1, p. 92.

A medium-sized civet, grizzled gray and black with a blackish stripe extending along the side of the neck from the posterior base of the ear, and having five to eight narrow dark stripes on the back that become broken into lines of spots laterally; feet and a small crescent about the anterior part of the eye dark brown; tail with six to nine dark rings alternating with white or buffy-tinted rings.

The type locality is Malacca and, although several subspecies have been recognized, Wroughton, in 1918, writes that he has entirely failed in finding one that seems valid. The series now available through the work of the Asiatic Expeditions comprises fifty-eight skins, mostly with skulls, from Yunnan, Szechwan, and Fukien, and twenty from Hainan. The Hainan series is uniformly slightly smaller in size of skull and with one exception represents the gray phase of pelage, while the others are larger of skull, have longer tails, and are practically all of the rufescent type. Since the former series agrees in skull measurements with those published for typical *malaccensis*, I am referring them to that form, the range of which probably includes the entire Malay Peninsula to the Chinese border and Hainan, for Thomas has lately identified as of this race the specimens taken by the Delacour Expeditions. Females average a few millimeters shorter than males in length of cranium and of toothrows.

Viverricula malaccensis pallida (Gray)

Viverra pallida GRAY, 1832, Proc. Zool. Soc. London, p. 63; 1834, 'Ill. Indian Zool.,' II, Pl. VI.

Similar to the preceding but the skull slightly longer in its dimensions (average condylobasal length of ten adult males 100.8 mm. against 95.6 in five adults from Hainan). Color averaging more ferruginous, tail longer, winter pelage longer and with less obvious stripes.

In his review of this genus in 1898, Bonhote regarded the Chinese animal as distinct, and used for it Gray's name *pallida*, based on the colored plate of a specimen sent by Reeves from China, though he published the same name earlier as a *nomen nudum*. While Reeves's animal probably came from the vicinity of Canton, and may therefore not be very different from typical *malaccensis*, yet the series from Fukien, not far to the northward, is so evidently different from the Hainan specimens taken as representing the typical form that it seems safe to apply Gray's name to them. This series of nearly sixty skins shows that the ferruginous phase is the usual one, and that the grayer type of coloring is very rare. In winter skins the pelage is much longer than that of the more tropical animal and has the stripes and spots much obscured. The number of rings on the tail, which has been used as a distinguishing mark, varies within narrow limits from occasionally as few as six to rarely nine, or even ten.

Mr. C. H. Pope, who secured most of the Fukien series, says that this is chiefly a ground-living animal, frequenting thickets and covered ravines, whence it may easily be driven by dogs.

Its range in China extends north to the Yangtze Valley, where specimens were secured by Mr. Granger at Wanhsien. Two others from southern Yunnan seem to be the same, and differ in their narrow, less inflated bullæ from the only Indian skull available. It seems likely that *V. m. thai* Kloss of Central Siam will prove not distinguishable from typical *malaccensis* by which its range is surrounded.

Paradoxurus hermaphroditus laotum Gyldenstolpe

Paradoxurus hermaphroditus laotum GYLDENSTOLPE, 1917, Kungl. Sv. Vet. Akad. Handl., Stockholm, LVII, No. 2, p. 26.

A series of eight adult skins from Hainan evidently represents the *hermaphroditus* group and, to this species, Dr. J. A. Allen has referred other Hainan specimens. The typical form, however, is restricted on the mainland to the southern portion of the Malay Peninsula, while in southern Siam (Trong) a slightly paler form is interposed, *P. h. ravus* Miller, 1913. Very recently Thomas has listed specimens from Annam as *P. birmanicus* Wroughton (type from near Sagaing, upper Burma), and it is unlikely that the Hainan specimens are very different for they agree fairly well with the description. Gyldenstolpe has shown, however, that his *P. h. laotum* is the same and was published over a month earlier, so that it is here used provisionally for the Hainan animal.

In the series of adults there are five distinct dorsal black stripes on a ground that varies from pale grayish buff to nearly golden. In one the entire throat to the upper chest and the sides and crown of the head are shining black, but in most these parts are much mixed with paler hairs; feet and tail black, the latter at its base more or less mixed with paler hairs, particularly on the lower side.

The only other paradoxure yet known from China is *P. exitus* Schwarz, from near Canton, a small animal, probably a race of *P. minor* Bonhote.

Paguma larvata larvata (H. Smith)

Gulo larvatus H. SMITH, 1827, in Griffith's 'Animal Kingdom,' II, p. 281, Pl.

A palm-civet without stripes or tail-rings. Head and nape to shoulders black; a white blaze on forehead sometimes extending a varying distance on to the occiput or neck as a narrow line of white-tipped hairs. A white mark below and another above the eye extending to base of ear and below it, often to a nearly complete half collar. Upper parts and proximal portion of tail grayish to ochraceous; feet and terminal half of tail blackish brown.

With the fine series of over thirty skins secured by the Asiatic Expeditions, I have attempted to review the nomenclatural history of this species. The name *Gulo larvatus* was given, in 1827, by Hamilton Smith, to a specimen in the Leiden Museum, that had been so labeled by Temminck; his colored plate from the same specimen is a fair representation of the animal as we now know it from South China, but the original locality was unrecorded. Temminck who later, in his 'Monographies' (1841, II, p. 329, Pl. LXV, figs. 1, 2), described it as *Paradoxurus larvatus* and figured the skull, stated that it had been obtained from London. Gray (1831, Proc. Zoöl. Soc. London, p. 95; 1832, p. 67) had meanwhile redescribed the species on the basis of a specimen from the vicinity of Canton, China, sent by Reeves, referring it first to a new genus, *Paguma*, then to *Paradoxurus*. Of this specimen he published a colored figure (1834, 'Ill. Indian Zoöl.,' II, Pl. XI), which, though in many respects crude, is nevertheless again a fair representation. For nearly three-quarters of a century the name stood, until Matschie, in 1908, concluded that Hamilton Smith's figure was really that of the Formosan race (named *taivana* by Swinhoe), and hence he renamed the subject of Gray's plate *Paguma reevesi*. Thomas has shown the distinctness of the island race and (1909, Ann. Mag. Nat. Hist., (8) III, p. 377) that it does not really correspond to H. Smith's description as well as do specimens from the lower Yangtze; moreover, it is unlikely that at that early date a living palm-civet would have reached London from Formosa, but while Thomas does not say that Hamilton Smith's animal is identical with Reeves's, I think it may safely be assumed that they both represent the typical form of South China. Thomas then proceeded to describe a new race, *hainana* from the island of Hainan, and by a curious coincidence, Dr. J. A. Allen also described the same form using the same subspecific name. His paper was issued April 17, 1909, while Thomas's was received at Cambridge, Mass., on the previous day from England, so that the latter author must stand as authority for the name. In the following year, Wroughton described as *P. l. intrudens* a large brightly colored race from Yunnan and Burma, the type locality, Myitkyina, North Burma, less than forty miles from the border of western Yunnan. In 1919, another race, *vagans*, with the hair of the upper parts black-tipped, was named from western Siam by Kloss, and finally, Thomas in 1921, added two more subspecific names, *yunalis* for the animal of western Yunnan, and *rivalis* based on a pale skin from Ichang on the Yangtze. As a basis for these various names, the material previously available has been admittedly inadequate, quite insufficient to indicate the range of variation in any single area. The series collected by the Asiatic Expeditions includes sixteen from Fukien Province, four from Szechwan, about 150 miles from Ichang on the Yangtze, a specimen from Chekiang Province, and eight (all but one without skulls) from western Yunnan. There is also a single young animal from Hainan. A careful consideration of this material makes it pretty certain that only two continental races are represented, namely, one from western Yunnan and the other from eastern Szechwan to the coast. The latter is the typical race, *larvata:* the former should probably stand as *intrudens*, of which *yunalis* would be a synonym.

The range of color variation shown by the Fukien series is considerable. The average skin has the entire back pale ochraceous buff, fading into nearly clear gray on the sides and belly. The underfur is smoky. The base of the tail is colored like the back, the terminal portion becoming black. The white blaze on the muzzle usually extends back between the ears and the whitish mark behind the ear seldom makes more than a narrow crescentic patch on either side. In the same series are individuals in which the ochraceous tinge becomes so reduced as to be practically wanting or in others very faint. At the opposite extreme are one or two in which the ochraceous tips of the body-hairs are so intensified that they are as bright as in the Hainan skin. While the black tip, on the average, includes the terminal half of the tail, in one it is only about a third, while three of the series (two from Fukien, one from Szechwan) lack the black tip altogether and have tails wholly gray or gray tinged with pale ochraceous. A specimen of this type from Kiating, Szechwan is recorded by Jacobi as *Paguma l. reevesi*, but he wisely remarks that it would be unwarranted to found a new race upon it, occurring, as it did, within the range of the typical form. The black tail-tip may be rather well defined, or it may extend as a darkened stripe nearly the whole length of the dorsal side of the tail. The amount of black in the subterminal portion of the longer hairs is further subject to much variation, while the exact extent of the white head-markings is hardly the same in any two skins. The usual condition, however, is to have the white frontal blaze continued back between the ears, but in at least two of the series (from

Fukien) it may be traced as a narrow line of white-tipped hairs nearly to the shoulders. A specimen from Wanhsien, Szechwan, however, has it well developed to the withers, approaching the condition found in *P. l. intrudens.* While usually more or less of the mustachial vibrissæ are white, in occasional skins they are all black. The chin is black, the throat mixed grayish.

This is an animal of the southern parts of China, hardly extending northward of the Yangtze basin. Mr. C. H. Pope writes that it is said to live in holes and is captured by being smoked out. Of the series secured in the Fukien and Szechwan Provinces, it is noticeable that a large proportion, though nearly full-grown, still have the well-developed milk dentition. This set of teeth evidently is retained for a considerable period, is perfectly functional, and not greatly inferior to the permanent set. Within narrow limits the individual teeth vary a good deal in size among specimens from the same locality and apparently independently of sex, so that too much reliance cannot be placed on the size of the teeth as a racial character. The peculiarly carinate audital bullæ are an interesting feature of the skull.

Paguma larvata intrudens Wroughton

Paguma larvata intrudens Wroughton, 1910, Journ. Bombay Nat. Hist. Soc , XIX, p. 793.

Similar to *P. larvata* but larger, the back a brighter, deeper tone of ochraceous, the white mark of the forehead extended as a broad stripe to the shoulders, and the facial markings, including the whitish half-collar, more clearly defined.

The type locality is Sima, near Myitkyina, in northeastern Burma, a short distance from the borders of Yunnan, and marks very nearly the western bounds of the species' range. The slightly larger size of the type and of individuals from western China is indicated by the longer skull, 118–120 mm. from back end of occipital crest to gnathion, as against an average of 113 mm. in Fukien specimens. Wroughton considered the few available specimens from western Yunnan the same as his Burmese race, but Thomas in 1921 described as *yunalis* two individuals that were brighter in their ochraceous tint, and with very small suborbital white mark. The type locality is given as Yen-yuen-sien, Yunnan, but it is really in southern Szechwan, about 250 miles east of Wroughton's type locality.

The series of skins secured by the Asiatic Expeditions from Lichiang and the Namting River shows, however, that the white suborbital mark is normally large and well defined instead of being a "mere vague streak," while the slight amount of variation in the ochraceous shade of the back is probably also chiefly an individual matter. I have therefore ventured to place the name *yunalis* in the synonymy of *intrudens*, which will be the name of the masked palm-civets of southern Szechwan to north-eastern Burma, south through western Yunnan to central Tonkin, whence Thomas has lately recorded specimens under the former name.

While the average skin of *intrudens* shows the white nuchal streak extending as a well-marked line to the shoulders, one from Lichiang has it very narrow and confined to the tips of the neck hairs, ending some 80 mm. from the posterior edge of the black shoulder area, while a second represents the opposite extreme, for the stripe, after continuing quite to the end of the black area, is interrupted for about 35 mm. and then continues indistinctly nearly the whole length of the back. Wroughton mentions a somewhat similar specimen. As in the typical race, an occasional specimen has an all-gray tail, without the black tip.

Herpestes urva (Hodgson)

Gulo urva HODGSON, 1836, Journ. Asiatic Soc. Bengal, V, p. 283.

A large mongoose with coarse, grizzled pelage of black and buffy or whitish; feet dusky brown, tail becoming whitish to buffy or ochraceous in its terminal part; a conspicuous white stripe from the corner of the mouth to the shoulder.

The so-called crab-eating mongoose is found in the lower country of South China. The collection contains a skin from Chinkiang, a fine series of 27 secured by Mr. Clifford H. Pope and Rev. H. R. Caldwell in Fukien, as well as four taken by the former collector in Hainan.

Matschie in 1908 gave the name *Urva hanensis* to the Chinese animal on the basis of four skins from Hankow, which, although no specimens from India were available for comparison, appeared to differ from the original description in the following particulars: (1) chin brownish gray, much mixed with white, instead of being white; (2) underfur on the head dark brown with a gray tone instead of light reddish brown; (3) under side ochraceous, feet blackish brown instead of both under side and feet dull brown; (4) tail 250 mm., instead of 275–300 mm. In the matter of color, however, the series at hand shows considerable variation not only in the extent of the white tipping to the hairs, the amount of white or brown on chin, throat and feet, but also in the intensity of the buffy tint, so that in some the underfur is almost whitish, in others rusty, and the basal portion of the long hairs on the tail varies between similar extremes. The measurement of the tail likewise seems not to be distinctive, so that until more obvious differences can be shown, Matschie's name is best regarded as a synonym. Of the four specimens from Hainan, two are immature, but the two adults are very dark in appearance due to a decrease in the extent of the white hair-tips and a corresponding increase in the black subterminal rings. One or two of the Fukien skins are indistinguishable, however, so that it is hardly feasible to separate the island animal.

Herpestes rubrifrons (J. A. Allen)

Mungos rubrifrons J. A. Allen, 1909, Bull. Amer. Mus. Nat. Hist., XXVI, p. 240.

A medium-sized species; long hairs ticked black and buffy white giving a finely grizzled appearance; head washed with ferruginous, and the long hairs of the tail faintly tipped with ochraceous; backs of feet russet, belly yellowish drab.

Several additional specimens from Hainan represent this species, the relations of which are apparently with *javanicus* of Java or the mainland *exilis* of Tonkin and Siam. There seem to be no records of other species of mongoose than *H. urva* from the mainland if we except Hilzheimer's *H. albifer* based on skins bought at Hankow. These may even prove to be young of *H. urva*, though Hilzheimer believed they were related to *auropunctatus*.

AMERICAN MUSEUM NOVITATES

Number 360 | Published by | July 17, 1929
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

599,74 (51)

CARNIVORA FROM THE ASIATIC EXPEDITIONS[1]

BY GLOVER M. ALLEN

In previous papers, brief reports have been made on the Mustelidæ and Viverridæ secured by the Asiatic Expeditions under the leadership of Dr. Roy Chapman Andrews for The American Museum of Natural History. The remaining groups of Carnivora are here dealt with, including the bears, wolves, foxes, and cats (families Ursidæ, Canidæ, Felidæ) of which a magnificent series of skins and skulls was brought back, adequate in some cases for a tentative revision of the many names applied to certain eastern species. The discrimination of geographic races among the larger predaceous mammals is often difficult. Sufficient series from a single region are seldom available for the determination of normal individual variation in color, pattern, or proportions, which has resulted in the frequent bestowal of new names on a quite inadequate basis. Moreover, large carnivorous mammals may often have a wide individual range, so that local varieties are not so easily established as in the case of smaller and more sedentary species. So far as possible, therefore, I have attempted to review critically the various names and descriptions involved for the region covered.

Ursidæ

Selenarctos thibetanus (Cuvier)

Ursus thibetanus F. CUVIER, 1824, 'Hist Nat. des Mamm,' Pl. CCXIII and text.

The Asiatic black bear is given generic rank as distinct from the typical genus *Ursus* on account of its color (black with a white crescent on the chest), and the formation of the plantar pads, which in the fore paws have an enormous carpal pad continuous with the palmar pad, while of the digital pads the first and fifth only are continuous with the latter. The species is forest-living and occurs from India to Manchuria and South China. A number of local races have been named, but it must be admitted that the discrimination of most of these rests upon a very slender basis, since nearly all are described from single skulls, often of unknown age or sex and without adequate comparison with the typical form. In these large species not only is the individual and sexual variation in skulls so great as to be readily apparent, but the changes coincident with age are also striking. Moreover, these are wide-ranging animals, and a single one may travel over more territory in a day than a mouse or shrew would cover in its entire lifetime, a factor tending to prevent the ready development of local forms. Increasing age is accompanied by a great increase of zygomatic width, accentuation of the lambdoid and sagittal crests, and by the enlargement and deepening of the glenoid cavity of the jaw, so that the cranium of an old bear when placed on a flat surface rests upon the glenoid portion of the skull or the paroccipital processes, instead of upon the condyles as it does in immature animals. Age is also accompanied by a fusion of the cranial bones, so that in adults the outlines of the frontal, parietal, and finally the nasal bones become quite obliterated.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History Contribution No 91

The Asiatic Expeditions secured four skins and skulls of black bears from the forests near Eastern Tombs, Chihli Province, which are thus topotypes of *S. t. wulsini* Howell. Unfortunately, the sex of none of these is known. Two are immature while the two others are adult, the larger perhaps a male. An adult female was also secured at the base of Tai Pei Shan, Shensi, and there are further, available for comparison, four adult skulls from northwestern Corea, Hupeh Province, and "India" respectively, the last representing typical *thibetanus*. A careful comparison of all these, and of the descriptions of *macneilli*, *mupinensis*, and *wulsini* reveals no single character whereby any local form of northern China may be distinguished. Sowerby (1920, Journ. Mamm., I, p. 213) has reviewed the bears of eastern Asia, particularly with a view to identifying those described by Heude, practically all of which he regards as valid species without recharacterizing them. He admits that *S. ussuricus* is much like *S. thibetanus* except that it "seems to have longer hair on the sides of the head and neck." The chief difference is believed to lie in the large size of the last upper molar, which in Manchurian specimens was 27 mm. long in a female, 31 mm. in a male, against 24 mm. in a female of *thibetanus* from the Himalayas and 28 mm. in a specimen representing *mupinensis*. However, in two skulls (unsexed) from India in the Museum of Comparative Zoölogy, representing *thibetanus*, the length of this tooth is 27 and 33 mm. respectively. In the Chihli series it varies from 28 to 32 mm. Evidently there is nothing diagnostic in the size of this tooth as a racial character. Lydekker's *macneilli*, from "some distance" west of Ta-chienlu, Szechwan, was supposd to differ in its smaller cheek teeth, last molar 25 by 15 mm., but in a skull from Hupeh (M. C. Z. No. 11770) this tooth is 30 mm. long. In *S. t. wulsini* the smaller size of the white chin-spot as compared to *ussuricus* was believed by its describer to be diagnostic, but the series of topotypes secured by the Asiatic Expeditions shows that this, like most white markings in mammals, is very variable and may be large or small (varying in four skins from 45 to 130 mm. in length). In *mupinensis* it is also said to be very small. It is evident from a study of the available material and descriptions that individual variation will acount for most of the supposed racial characters in the subspecies described, and that no truly geographic differences have yet been pointed out that will separate the Himalayan black bears from those of North China.

Selenarctos thibetanus melli Matschie

Selenarctos melli Matschie, 1922, Arch. f. Naturgesch., A, LXXXVIII, pt. 10, p. 34.

Matschie, in 1922, gave the name *melli* to a black bear from Kwangtung Province, near Canton, in South China. The type was captured as a cub, and kept for some three years in captivity, hence may be presumed to show the usual abnormalities of captive animals. Its chief character is said to lie in its small size, for it shows the usual color pattern of *S. thibetanus.* A fine skin and skull from Chunganhsien in Fukien Province was secured by Mr. Clifford H. Pope of the Third Asiatic Expedition and may be regarded as of the same race. It is an adult male with the teeth much worn and all the cranial sutures quite obliterated. In size the skull about equals that of an adult female from Shensi, and since adult females are smaller than males, this may indicate that *melli* is really a smaller subspecies of South China. The single specimen from Fukien is obviously of much less size than the large skulls of *S. thibetanus* assumed to be those of males. The skin, taken in April, is in excellent condition and much shorter-haired than the winter skins from Chihli. If this specimen adequately represents the South China black bear, it seems to indicate a valid race, characterized by its smaller size and shorter coat. Mr. Pope also secured a very young black-bear cub from the island of Hainan that doubtless represents the same animal. Although long ago recorded from this island by Swinhoe, no adult specimens of the black bear seem to have reached museums from Hainan.

Canidæ

Canis lupus laniger (Hodgson)

Lupus laniger HODGSON, 1847, Calcutta Journ. Nat. Hist., VII, p. 474.

The wolf of Mongolia and northern China does not seem to be very different from the typical European race. Three skulls, one of a male, measure about the same as European skulls though none equals in size the large Swedish skull, the dimensions of which are published by Miller (1912, 'Mamm. Western Europe'). In color, the seven skins secured by the Asiatic Expeditions vary considerably according to season and condition of wear, but the best one, killed near Urga, is decidedly pale, the muzzle pale ochraceous-buff grizzled with whitish, forehead slightly darker, backs of ears and an area about their bases contrastingly orange-rufous, fore legs pale buff without trace of the dark stripe on forearm; neck, body, and tail with the usual ochraceous element reduced to buff, the white rings of the guard hairs prominent. Other Mongolian skins are considerably darker: buffy grizzled with black and the forearm stripe may be well developed. The underfur is thick and woolly, in the winter coat especially. In view of the variation in color among wolves of the same region, from pale grayish animals to buff-colored specimens with greater amounts of black in the pelage, it is evidently unwise to recognize several species among them as Matschie has done, unless more essential differences can be established than those shown in the native skins without definite locality which were made by this author the basis of his *Lupus filchneri* and *L. karanorensis*. He also names a third species, *Lupus tschiliensis*, on the basis of a skull, sex unknown, from Chihli, but the measurements are identical with those of Mongolian skulls and the slight differences in cranial proportions upon which he relies are best regarded as purely individual variations. Probably Hodgson's name *laniger*, based on the wolf of Tibet, is applicable to the wolf of Mongolia and North China, an animal very little paler and smaller than that of western Europe.

Cuon rutilans (S. Müller)

Canis rutilans S. MÜLLER, 1839, 'Verhand. Zool. Zoogd.,' pp. 27, 51.

Size of a small wolf; color bright rusty rufous, the tail blacker with a black tip; belly, throat, and edge of upper lip usually white.

Two skins from Yenping, Fukien Province, taken by Rev. H. R. Caldwell, seem to be the first definite records for the province. They are not certainly distinguishable in color from two other skins from western Yunnan (Namting River and Shafun). One of each pair has the belly suffused with the reddish tint of the back.

The type locality of this animal is Bengal, but probably it is not very different from the earlier described *Cuon javanicus* (Desmarest) of Java, of which it may eventually prove to be the mainland subspecies.

Nyctereutes procyonoides (Gray)

Canis procyonoides GRAY, 1834, 'Illustr. Indian Zool.,' II, Pl. I.

Small, fox-like, with short bushy tail; color a mixture of buff, gray, and black, the black-tipped hairs predominating over the back and in a narrow dorsal line from the crown to the tip of the tail; a conspicuous blackish-brown patch on each side of the face from just in front of and below the eye to a point midway to the ear and continued as a narrower line behind the ear. The flanks, sides of neck, and the tail are chiefly a warm buff; feet blackish brown.

Gray's original specimen was sent by Reeves from China, hence no doubt from near Canton. The large series of some twenty specimens, collected mainly by the Asiatic Expeditions, includes ten from Fukien Province which may be taken to represent true *procyonoides.* Three others from eastern Szechwan (Wanhsien) are quite the same, as are also those from Kiangsu, Chekiang, and Hunan Provinces. There is a wide variation in color among skins from the same locality, some having the black-tipped hairs of the back so numerous as to darken the whole upper side while in others they are chiefly confined to the median dorsal line. The entire pelage is more or less suffused with pale ochraceous which is in some skins intensified to a bright rusty. Winter skins in good condition are longer-furred than those of summer. A Fukien specimen taken in December shows the extreme of the intensification, in being almost fox-red all over except for the usual blackish areas and the black-tipped hairs of the dorsal line.

Matschie, in 1908, gave the name *stegmanni* to the racoon-dog of the Yangtze basin, type locality Chunkiang, at the same time stating that the *N. sinensis* of Brass, also from the Yangtze Valley was a synonym of *procyonoides.* The characters he gives (based on a single skull) are, however, unreliable and do not hold good in the present series, so that both these names are undoubtedly synonyms of *procyonoides.* No specimens are at hand from North China, so that it is uncertain if the species varies geographically in that part of its range. Matschie gives names, however, to the slightly larger Ussuri animal as well as to that from Amur Land.

Nyctereutes procyonoides orestes Thomas

Nyctereutes procyonoides orestes THOMAS, 1923, Ann. Mag. Nat. Hist., (9) XI, p. 657.

A slightly paler race. The type was an adult female from the northwestern flank of the Likiang Range of Yunnan and constituted the first record of the genus in western China. Four additional skins (two with skulls) were secured from the same range by the Asiatic Expeditions, and show that the Yunnan animal is after all very similar to that of southeastern China, differing chiefly in the gray instead of buff tone to the paler portions of the longer hairs, though there may be a very slight suffusion of buffy. The throat and feet are black in the type but brownish in the four other skins, while the nearly parallel condition of the zygomatic arches, which formed the chief basis of separation, is evidently an individual aberration since the two other skulls show nothing to distinguish them from those of the typical race. Thomas mentions the abnormal presence of an upper third molar on the right side in his specimen, a peculiarity found on the left side in a specimen collected by the Asiatic Expeditions in eastern Szechwan.

Vulpes vulpes hoole Swinhoe

Vulpes hoole SWINHOE, 1870, Proc. Zool. Soc. London, p. 631.

Similar to the red fox of Europe but the sides and especially the thighs more mixed with gray, the fore feet usually with less black, and the red tones less fulvous but more chestnut. The tail has the chestnut confined more to the upper surface; the lower surface is buffy white, its longer hairs black-tipped. Below, white to gray or even pinkish.

A series of seventeen skins, mostly with skulls, from Fukien Province is instructive as showing the range of individual variation in a restricted locality. Although the average skin is more chestnut above with grayer thighs and has a tail that is paler below, clouded with slaty, as compared with European red foxes (Scotland and Germany), nevertheless, there are occasional individuals that differ very little indeed from these latter. In general, the clear chestnut area is confined to a rather narrow median stripe with ill-defined boundaries, becoming more rufous on the tail. The flanks are bright ochraceous frosted with gray-tipped hairs which especially predominate on the sides of the haunches. The blackish area on the sides of the muzzle may be well developed or very indistinct or wanting altogether. The black stripe on the front of the fore leg is usually narrow, bordered by rufous, but may be broad enough to cover the entire front of the leg and extend up on the shoulders. In dark specimens the throat and belly are suffused with slaty where the dark bases of the hairs show through, and in one skin the wearing away of the white tips of the hairs forms an indistinct black collar. Usually a narrow line of clear bright ochraceous runs along the sides bordering the belly. The last is usually white with grayish underfur, but occasionally the whole under side of the body is deep pinkish buff. In the entire series no skin shows the blackish belly so often seen in Egyptian or European red foxes. Swinhoe, however, found this variation in Fukien and believing it to represent an upland race, named it *lineiventer*. But there can be but little doubt that all the foxes of South China are really referable to a single subspecies to which Swinhoe's first name is applicable, for specimens secured by the Asiatic Expeditions from Chekiang, Hunan, and Maitai Chao, Shansi, do not show any essential differences. Matschie, in 1908, gave several names to foxes from eastern Asia, based on skins purchased in fur markets, but probably most of these are synonyms of *V. v. hoole* or of forms already described from eastern Tibet. His *Vulpes aurantioluteus*, presumed to have come from the mountains of the upper Yangtze, is doubtless the same as *V. v. hoole*, with which it exactly corresponds in its description.

The average condylobasal length of four adult males from Fuching, Fukien, is 135.1 mm., of four females 127.8 mm.

A beautiful skin from Lichiang, Yunnan, is unusually deep in color, the fore and hind feet black, the entire back more fulvous than usual, and the tail much darkened with black. In its general appearance, however, it corresponds with *V. v. hoole*.

Vulpes vulpes tschiliensis Matschie

Vulpes tschiliensis MATSCHIE, 1908, 'Wiss. Ergebn. Exped. Filchner, X,' pt. 1, p. 169.

A larger northern race of similar coloration to the last.

In describing this fox, Matschie supposed that its chief distinguishing feature lay in having the backs of the ears brown instead of black. The type is a mounted specimen from Peking in the Berlin Museum, and may have been somewhat faded, for another skin from the same locality, he says, has the ears blacker.

A single skin secured by the Asiatic Expeditions from Eastern Tombs, in the same province, can be closely matched by one of the less grizzled, fulvous specimens from Fukien. It has, however, a minimum of black on the feet, and lacks any dark mark on muzzle and chin. But its skull is so much larger than in any of the Mongolian or South China foxes, and in this respect seems to agree so well with the cranial measurements given by Matschie, that it may perhaps represent a distinct northeastern race and I am therefore retaining Matschie's name for it. The condylobasal length is 157 mm., which is 22 mm. greater than the average of four male skulls from Fukien. Skulls from Shensi and Shansi are of intermediate size to 148 mm. for condylobasal length.

This skull is but little inferior in size to one recorded by Ognev from southern Ussuri, eastern Siberia, under the new name *dolichocrania*, the greatest length of which is given as 167.1 mm., while the same dimension (occiput to front of incisors) in the Eastern Tombs skull (A. M. N. H. No. 57070) is 165 mm. It may, therefore, prove that *tschiliensis* ranges to the Ussuri region and that Ognev's *dolichocrania* is a synonym of it.

Vulpes vulpes ?karagan (Erxleben)

Canis karagan ERXLEBEN, 1777, 'Syst. Règne Anim.,' p. 566.

A pallid form, straw-yellow, with rusty on back, neck and shoulders; the paws straw-yellow, with or without black marking.

The collection contains an adult male skin and skull from Tsagan Nor, a skull from Loh, and two young from Tze Tzen Wang, Mongolia, as well as a skin from the Tianshan Range, but all these skins are in such poor condition of pelage through wear and moult, that their true coloration is undeterminable. The feet and noses of the adults, however, appear to be much paler in color than in the more southern foxes of China, so that the specimens doubtless represent a more pallid race, probably close to *V. v. karagan* of the Kirghiz Steppe. In his recent review of the foxes of Russia, Ognev mentions a skin collected by Koslov near Kiakhta and another from the steppes of southern Transbaikalia that seem practically indistinguishable from this race, but it is not clear that the additional forms he names as *V. v. ockroxantha* (Tian-Shan) and *V. v. jakutensis* (south of Yakutsk) are really very different. I am therefore provisionally regarding the Mongolian red fox as *V. v. karagan*.

Felidæ

Felis bengalensis bengalensis Kerr

Felis bengalensis KERR, 1792, 'Animal Kingdom,' p. 151.

A dozen skins from Lichiang and Wei-shi, Yunnan, are referred to the typical race of the small spotted tiger-cat which, according to Wroughton, is found in India from southern Beluchistan to Upper Burma and Tenasserim. Although about the size of a house cat, it may at once be distinguished by the pale mark on the middle third of the back of the ear and by the absence of a dark tip to the tail. Its essential pattern consists of stripes and spots on an ochraceous ground, as follows: two narrow black stripes, one from the posterior ccrner of the eye, the other from just below the eye, pass back along the side of the jaw enclosing a white area between them; the lower stripe is more or less continuous across the upper throat with the corresponding one of the opposite side and there are three or four other imperfect blackish-brown collar-marks on the lower throat; a short white stripe borders the inner and upper edge of the eye; four narrow black stripes run from the upper corner of the eyes to the shoulders, with sometimes a narrow median one on the forehead and crown; the two outer of these become broader posteriorly breaking up into large lengthwise blotches over the shoulders; the inner pair likewise becomes interrupted at the shoulders, but from there is traceable as a nearly continuous pair of stripes to the root of the tail; the sides of the body are marked by about five longitudinal rows of elongate spots which may be all black, or more or less surrounded by ferruginous, or the anterior part of the spot may be of the latter color, the posterior part black. These markings are larger in the males than in females. The belly has a number of blackish-brown spots on a white ground. The tail is buffy with ten or more broken rings of blackish.

In the Yunnan series, the ground color is bright buff or yellowish, sharply marked off from the belly which is white. There is a good deal of ferruginous on the shoulder region, not only tinging the ground color but broadly edging the spots and markings. In extreme specimens the body spots may be chiefly bright rusty slightly and incompletely bordered with black, while at the opposite extreme are skins in which the ferruginous is nearly suppressed, so that the markings are nearly all black on an ochraceous-buff ground. To this latter type belongs the skin described as *Felis anastasiæ* by Satunin, as Lönnberg has recently intimated.

Felis bengalensis chinensis Gray

Felis chinensis Gray, 1837, Mag. Nat. Hist., I, p. 577.

Similar to the typical race in all respects but the back is less clear ochraceous, with a decided gray tinge, and the flanks are grayish.

The collections include a large series of some thirty skins and nearly as many skulls from eastern Szechwan (Wanhsien), Hunan (Yochow), Fukien (Futsing and Yenping), Hainan (Nodoa), and a few other places. They all agree in the somewhat grayish tint to back and sides instead of the clear warm buff to ochraceous of the typical animal. There is much variation in the pattern and size of the markings. Males are larger, with larger markings than females, and in old age the skulls have a low sagittal crest formed by the union of the temporal ridges, whereas in none of the females seen does this ridge form. Peculiarities of the teeth are the frequent loss of the first upper premolars and in the upper carnassial (p^4) the antero-internal lobe is often much reduced in size or it may even (as in a case noted by Lönnberg) be practically suppressed. In old animals the orbit may be closed by the fusion of the postorbital process with the ascending process of the jugal.

Milne-Edwards's *Felis scripta* is either based on this subspecies whose variation in markings is so deceptive, or it may possibly represent a slightly darker race. Probably also that author's *F. microtis* from near Peking is only a small female of the same, for the supposed reduction of the ears is said by Elliot, who examined the type (and spelled the name *macrotis*), to be fallacious, for they are really of normal size. A large skin, perhaps of a male somewhat stretched, but probably representing the same animal, became the basis of Milne-Edwards's *F. decolorata*, also from near Peking. It may later prove that the tiger-cat of North China is a distinct race, in which case the name *microtis* will be available for it, provided this in turn is not identical with Radde's *F. undata* of Amur Land, which is at most a geographical race of *bengalensis*. In the lack of comparable material from North China, however, this point cannot be settled now.

Felis temmincki dominicanorum P. L. Sclater

Felis dominicanorum P. L. Sclater, 1898, Proc. Zool. Soc. London, p. 2, Pl. i.

About twice the size of a house cat, yellowish brown to grayish brown above, the crown, neck and mid-line of the back bright ferruginous; two short white lines from the inner corner of the eyes continue as dull gray lines to the top of head; a white line from just below the eye to side of neck, bordered above and below by russet and black; backs of ears black mixed with gray centrally; a clear gray patch behind ear; feet grizzled gray; tail like the back, with a black tip and whitish lower median line; belly whitish with a row of dark spots on each side.

Four handsome specimens of this cat were secured by Pope in northwestern Fukien. Its range no doubt is more or less continuous across the wooded mountainous parts of southern China to Nepal and the Malay Peninsula. The type locality of *F. temmincki* is Sumatra but no comparisons seem to have been made between Sumatran specimens and those of China, though Lönnberg has shown that a skull from northern Siam is practically identical in measurements with one from China. An adult skull from Nepal is slightly smaller with more inflated bullæ.

Lydekker in 1908 gave the name *Felis temminckii mitchelli* to the animal of Szechwan on the basis of a single skin, and in 1924 Sowerby described a specimen from Tengyueh, Yunnan, as *F. t. bainesi.* In view of the variation in color among cats, and the fact that the species, like *F. aurata* of West Africa, believed to be closely related, occurs in a rufous and a browner phase, it is likely that these are not valid races. Matschie's *Felis* (*Catopuma*) *melli* is undoubtedly a synonym of *F. t. dominicanorum,* as well as *F. t. badiodorsalis* A. B. Howell, proposed in place of *melli,* preoccupied.

In addition to the four typical specimens secured at Kuatun, Fukien, by Mr. C. H. Pope, he obtained a fifth (an adult female) from the same locality which agrees in size and in cranial characters with these but differs remarkably in that, instead of being without markings on the body, it has a distinct color pattern of stripes and spots. Like usual skins of *temmincki,* it has black ears, slightly grizzled with gray in the middle of their posterior side, a clear gray patch behind each ear, grizzled gray feet, and bright ferruginous shoulders and mid-dorsal area. The head and body, however, are marked with a pattern practically identical with that of *Felis bengalensis.* There are two narrow lines of black down the back with a less clearly marked pair external to them, then about four rows of elongate blotches and spots, each with an ochraceous center incompletely ringed by a broken black margin, heavier at the posterior side. A row of blackish spots is present on each side of the belly. The tail, in addition to the usual pattern of ferruginous above, white below, with a black tip, also has about fifteen black bars, much as in the smaller species. At first sight, this animal might be thought a hybrid between *F. t. dominicanorum* and *F. b. chinensis,* both of which occur together here, although the latter is commoner at lower altitudes, but it seems equally probable that it represents either a reversion to a more primitive striped and spotted condition or a retention of the pattern that is probably characteristic of babyhood.

Felis nebulosa Griffith

Felis nebulosa GRIFFITH, 1821, 'Descr. Vert.,' p. 37.

Size of a leopard; the grayish-ochraceous ground color has some four or five large blotches on the sides, each outlined in black, forming a rim that is narrower or broken on the anterior side; forehead with many small black spots; two pairs of black stripes from occiput to shoulders, whence the median pair continues more or less broken on to the base of tail; belly white with elongate blackish spots.

A skin from Yenping, Fukien, and another, smaller with the black marks less developed, from Hainan, represent this species. The slight differences in color and pattern are probably individual, and since Griffith's type was an animal supposed to have come from near Canton, the Fukien skin may be regarded as typical, and Matschie's *Felis* (*Neofelis*) *melli* from Kwangtung a synonym. Material is lacking to determine the status of the Sumatran animal to which Horsfield gave the name *F. macrocelis*.

Felis pardus perniger (Hodgson)

Leopardus perniger Hodgson, 1863, 'Cat. Mamm. Nepal,' p. 3.

The type locality of Linnæus's *Felis pardus* has been fixed by Thomas as Egypt, and Hollister shows that skins from the southern part of that country are ochraceous buff, hence somewhat pallid, in ground color. African leopards seem to be either large-spotted or small-spotted, the latter perhaps the more usual condition. The series of eleven from Fukien and eastern Szechwan, secured by the Asiatic Expeditions, are uniformly rich ochraceous in ground color, with a pattern of large spots. There is a spinal series of large black spots forming two rows, while laterally the spots become more nearly circular, either with ochraceous centers completely ringed, or with the rings broken anteriorly or in two or three places. Immature specimens are paler in color than adults.

Although various names have been given to leopards in the East, it can hardly be said that any of them rests upon a satisfactory basis. Cabrera has pointed out that Hodgson's *Leopardus perniger*, based on a melanistic individual from Nepal, is the oldest name available for an Indian leopard, and since it is likely that the animal of South China is the same, I am provisionally using it for the latter. Three leopard skulls from India (two from Amballa) are a little different in the form of the nasals from the Chinese series, in which these bones are slightly more flattened and triangular, tapering to a median point behind instead of maintaining their width farther back and ending in an abruptly rounded outline. These differences are slight, however, and may not hold in a larger series of Indian skulls. Other available names for the eastern leopard are: *melas* of Péron and *variegata* of Temminck, both based on specimens from Java, Matschie's *Panthera hanensis* based on skins from Hing-an-fu and *Felis pardalis sinensis* of Brass applied to leopards of South China. The likelihood is, however, that the latter do not materially differ from Indian examples. Although specimens from North China are not available to determine the validity of the race currently called *fontanieri* (type locality Peking), Cabrera has suggested that the name *orientalis* of Schlegel (type from Amur) may be found applicable to it instead.

Felis tigris Linnæus

Felis tigris Linnæus, 1758, 'Syst. Nat.,' 10th Ed., I, p. 41.

Three handsome tiger skins with skulls, from Fukien Province, do not seem to differ essentially from the only Indian tiger available for comparison. The three are similar in their rich tawny ground-color, but differ in the details of the black stripes. In the adult male, No. 45519, the body stripes are broad, and much broken into lozenge-shaped blotches, with wide borders enclosing a bright rufous center. The stripes on the hips and haunches are, however, clear, wide, and continuous. A second skin shows the opposite extreme, with very narrow stripes, much less broken over the body, but tending to be short or incomplete; while the third is somewhat intermediate, with the stripes more broken and tending to form blotches open on the anterior upper part, enclosing areas of tawny. Hilzheimer (1905, Zool. Anz., XXVIII, p. 594), in comparing five Chinese tiger skulls with three from India, believed that the Chinese skulls could be distinguished by having the highest point of the skull just ahead of the postorbital processes instead of over them, and by lacking a small antero-external supplementary cusp on the upper carnassial, present in Indian skulls. These differences do not seem to hold good, however, for in the three skulls from Fukien the highest point is behind the postorbital process in one, ahead of it in the two others, while the supplementary cusplet of the upper carnassial is well developed in the large male, slightly developed in the second specimen and not at all in the third. Hilzheimer, relying on the report of an expert fur dealer, believed that there are differences in pelage between the Indian and the South China tigers, but it seems doubtful if these are of recognizable value in nomenclature, so that for the present Hilzheimer's name *amoyensis* for the tiger from Yunnan to Fukien may be regarded as probably a synonym. Following Pocock, I retain the generic name *Felis* for the tiger and the leopard, although both may be included in a subgenus, *Panthera*.

Lynx lynx isabellina (Blyth)

Felis isabellina Blyth, 1847, Journ. Asiatic Soc. Bengal, XVI, p. 1178.

A large short-tailed cat, of a general frosted reddish above, white below with a few blackish spots on inner side of fore limbs and on the sides of belly; legs and flanks with indistinct reddish spots; a broad white border to the eyelid, interrupted by a black spot near posterior upper margin; cheeks with three or four indistinct stripes of reddish brown; upper half of ear, its terminal pencil, a black spot on the lower cheek, and the tip of the tail, black.

A large skin from fifteen miles northeast of Urga, Mongolia, is interesting as perhaps marking nearly the southern boundary of this lynx's range in this part of Mongolia, where the coniferous forest and its northern fauna reach the edge of the Gobi Desert.

AMERICAN MUSEUM NOVITATES

Number 361 | Published by The American Museum of Natural History New York City | July 20, 1929

59.57,96 (51)

SOME ANTS FROM CHINA AND MANCHURIA[1]

BY WILLIAM MORTON WHEELER

The following paper contains a record of a number of Chinese and of a few Manchurian ants recently sent me for identification by Mr. Rufus H. Lefevre, Professor Chenfu F. Wu, of the Yenching University at Peiping, Professor S. F. Light, of the University of California, Professor N. Gist Gee, Mr. H. H. Chung, formerly a student at the Bussey Institution, Professor A. P. Jacot of the Shantung Christian University, and Messrs. P. H. and S. H. Dorsett of the Federal Department of Agriculture.

FORMICIDÆ

Ponerinæ

Odontoponera transversa F. Smith.—Three workers from Hongkong (R. H. Lefevre).

Ectomomyrmex astutus F. Smith.—Three workers from Mokanshan (N. Gist Gee) and one from Foochow, Fukien (H. H. Chung); three deälated females from Hongkong (R. H. Lefevre).

Ectomomyrmex tonkinus Santschi.—I have cited this species as *astutus* in some of my previous papers, but it is evidently distinct. The materials in my collection (all workers) are from the following localities: INDOCHINA: Loakay and Coxan (F. Silvestri). CHINA: Hongkong (R. H. Lefevre); Repulse Bay, Hongkong and Kusang (F. Silvestri); Amoy, Kuliang and Back Liang (S. F. Light).

Ectomomyrmex japonicus Emery.—Three workers from Leng-oo (C. W. Howard) and Kuling, near Kin-Kiang (N. Gist Gee); two females from Soochow and Loka, between Shanghai and Foochow (N. Gist Gee).

Ectomomyrmex horni Forel.—A single worker from Foochow (F. Silvestri).

Euponera (*Brachyponera*) *nigrita* Emery subsp. *chinensis* Emery.—One worker and an immature male from Soochow.

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No 314

Euponera (*Brachyponera*) *solitaria* F. Smith.—Numerous workers from Tsingtau, Shantung (R. H. Lefevre) and four from Peking (C. F. Wu).

Odontomachus hæmatoda L.—Five workers from Peking (C. F. Wu).

Myrmicinæ

Aphænogaster (*Attomyrma*) *geei* Wheeler.—Two workers from Peking and two from Soochow (C. F. Wu).

Aphænogaster (*Attomyrma*) *smythiesi* Forel var. *sinensis* Wheeler.—A worker, deälated female, and male from Peking (C. F. Wu).

The female (undescribed) closely resembles the female of the subspecies *japonica* Forel, but has the head, thorax and petiole deep castaneous brown, with broader pale brown borders to the gastric segments, the legs somewhat darker and more brownish, the anterior half of the mesonotum smooth and without traces of the fine concentric striæ of *japonica*. The epinotal spines are of the same length but somewhat more slender and more acute.

The male (undescribed) measures about 4.3 mm. It is black and shining, with the genitalia and terminal tarsal joints yellowish. Head opaque, densely and finely punctate, rounded-subrectangular, nearly as long as wide through the eyes. Mandibles with three distinct teeth. Thorax broad and robust; mesonotum strongly overarching the pronotum; epinotum short and very low, the dorsal outline of the base concave, twice as long as the declivity, with which it forms a blunt angle, and without traces of teeth. Legs slender; hind femora simple, not bent. Wings with two cubital cells, grayish hyaline, with very pale yellowish veins and pterostigma.

Messor aciculatus F. Smith.—Numerous workers from Weihsien, Shantung (R. H. Lefevre); workers, a male and female from Peking (C. F. Wu).

Pheidole tsailuni, new name for *Ph. concinna* Wheeler (1928), name preoccupied, Santschi (1910). Dedicated to Ts'ai Lun, the Chinese eunuch, who invented paper A.D. 105.

Pheidole javana Mayr.—Several soldiers, deälated females and workers from Foochow (H. H. Chung). These agree very closely with the typical Indonesian form of the species.

Pheidole javana var. **desucta**, new variety

SOLDIER.—Differing from the typical *javana* in color, being brownish yellow, with the head, except the cheeks, the gaster, borders of mandibles and median portions of femora and tibiæ brown; the antennal scapes black.

WORKER.—Differing from the worker *javana* in a similar manner but even paler than the soldier; the legs scarcely infuscated, the scapes brown.

FEMALE (deälated).—Very similar to the female of the typical *javana*, but the scapes, mandibles, gula and sides and articulations of the thorax paler, reddish brown.

Described from two soldiers, five workers and six females taken by Professor S. F. Light at Back Liang.

Pheidole nodus F. Smith subsp. *rhombinoda* Mayr.—Workers from Back Liang (S. F. Light) and Peking (C. F. Wu); soldiers, workers and females from Tsingtau and Weihsien, Shantung (R. H. Lefevre); soldiers and workers from Chao Yang and Shantung (A. P. Jacot).

From a study of the specimens in my collection I am convinced that Mayr's *rhombinoda* (1878) is merely a subspecies of Smith's *nodus* (1874) of Japan. The latter is somewhat smaller in all the female castes (soldier, 4–4.5 mm.; worker, 2.3–2.5 mm.; female, 5.5–5.7 mm. as compared with *rhombinoda:* soldier, 4.5–5 mm.; worker, 2.8–3 mm.; female, 6.3–6.6 mm.). The head of the soldier *nodus* is distinctly smaller, less deeply excised and impressed behind and more coarsely sculptured. The humeri are somewhat more rounded, the body is less shining, the tibiæ more hairy and the color is darker in both soldier and female. The latter is also more heavily sculptured and less shining than the female of *rhombinoda*. Wings opaque brown, with pale brown veins and pterostigma. I refer the specimens recently collected by Prof. F. Silvestri in Japan and described in my paper of 1928 to Smith's type because he gives the color as "obscurely ferruginous." The form collected by Sauter at Okayama, Japan and described as Smith's *nodus* in my paper of 1906 is really a pale variety, which may be called **prævexata,** new variety. The soldier of this form is of the same size as the typical *nodus* but yellowish ferruginous, with the thorax and petiole paler and the legs yellow, the scapes dark brown. The worker is yellowish brown with the gaster and posterior portion of the head somewhat darker. The female is dark red, with the legs and epinotal declivity paler and more yellowish, the gaster dark brown, except at the base.

The subspecies *rhombinoda* seems to be common and widely distributed in China. The soldiers differ from those of India and Indochina in my collection in having the head somewhat less deeply excised and impressed behind and are therefore more like the typical *nodus*. Further study may show that the Chinese form should be regarded as a distinct race or variety. For the present I arrange the known forms of the species as follows:

Pheidole nodus F. Smith

- Subspecies *nodus* F. Smith. Japan
    - Variety *prævexata,* new variety. Japan
- Subspecies *rhombinoda* Mayr. India, Ceylon, Burma, Indochina, China
    - Variety *formosensis* Forel. Formosa
    - Variety *micantiventris* Forel. Ceylon, Indochina
    - Variety *taprobanæ* Forel. Ceylon
- Subspecies *stella* Forel. Sikkim

Pheidole rinæ Emery subsp. *taipoana* Wheeler.—A single soldier from Hongkong (R. H. Lefevre).

Cardiocondyla nuda Mayr.—A single worker from Foochow (H. H. Chung).

Crematogaster (*Acrocœlia*) *brunnea* F. Smith.

There is much confusion in the literature in regard to the forms regarded as subspecies and varieties of this species, originally described from Borneo. Emery, in the 'Genera Insectorum' (1921, p. 149) divided the species into four subspecies, namely, *brunnea, sensu stricto, contemta* Mayr, *politula* Forel, and *subnuda* Mayr, each represented by several varieties. More recently Santschi (1928, Bull. Ann. Soc. Ent. Belg., LXVIII, p. 33) has brought this group into connection with *C. laboriosa* Smith of Japan, and remarks: "The Crematogasters assembled about *Cr. brunnea* Sm. by Emery and Forel may be divided into two species. One of them, which may be assigned to *Cr. laboriosa* Sm. is characterized by the disk of the petiole being broader than long and the [epinotal] spines being generally very short or dentiform. This species comprises the races and varieties *matsumurai* Forel st. *subnuda* Mayr, var. *formosensis* Wheeler [*recte formosæ*], st. *contemta* Mayr, var. *notabilis* Forel, st. *politula* Forel, var. *confucii* Santschi, var. *mongolica* Santschi, st. *ruginota* Forel, var. *tagala* Forel, var. *zoceënsis* Santschi. The other species has the petiole longer than broad and the spines longer, slender and often more erect. It is represented by *Cr. brunnea* Smith and its var. *nicevillei* Forel, *rabula* Forel and *sundaica* Forel."

The acceptance of the interpretations proposed by Emery and Santschi must obviously depend on the precise identification of Smith's *brunnea* and *laboriosa*, both of which were inadequately described. Both Mayr and Emery saw types of *brunnea*. The former pronounced it to be very close to *contemta*, the latter as almost identical with *rabula* Forel. Now Forel describes the petiole of *rabula* as trapezoidal, though somewhat narrower than that of *contemta*, and Bingham states that *rabula* is scarcely distinguishable from *subnuda*. None of the authors mentioned implies that the petiole of *rabula* is longer than broad. Were this the case it could hardly have passed unnoticed. In specimens recently taken by Mjöberg and belonging almost certainly to the typical *brunnea* (they were taken in the type-locality, Sarawak!), I find the petiole trapezoidal, broad at the base, strongly angular at the sides, in large individuals fully as broad as long and in smaller individuals broader than long. Furthermore, in my recent paper on the ants of Japan I have redescribed what is, in all probability, Smith's *laboriosa*. It proves to be an independent species, related to the Mediterranean *auberti* Emery and quite different from *brunnea* and its subspecies. The worker is characterized by the peculiar petiole, which is small, only slightly broader than long, rounded anteriorly, with nearly straight, parallel sides, by the postpetiole which has strongly separated tubercles, by the subcarinate mesonotum and longer, more slender and more distinctly three-jointed antennal clubs. I have not seen specimens of this species from China. All of my material from that country belongs to subspecies of *brunnea*. I therefore prefer Emery's interpretation to Santschi's, but would include under Smith's species also the Japanese *matsumurai* Forel as a subspecies, of which I regard *zoceënsis* Santschi as a Chinese variety. In my opinion *ruginota* Forel should also be regarded as a subspecies distinct from *politula* Forel, and *formosæ* Wheeler of Formosa, *vagula* Wheeler of Japan and *tagala* Forel of the Philippines may be assigned to it as varieties. These forms are all closely related to the subspecies *subnuda* Mayr. Obviously, till some local myrmecologist in China can make a careful study of this whole perplexing group of Crematogasters, all our arrangements of the various subspecies and varieties must be tentative. I believe, however, that some of Santschi's allocations are erroneous, e.g., in addition to *brunnea* and *rabula*, previously discussed, he places in his species with long petiole also *sundaica*. Many specimens of this form recently received from Java show that it is closely related to *subnuda* of which it was described as a variety by Forel, and has a similar broadly trapezoidal petiole.

Crematogaster (Acrocœlia) brunnea subsp. **contemta** var. **contemtior,** new variety

WORKER.—Length, 2.3–2.6 mm.

Smaller than the typical *contemta*, with shorter epinotal spines, which are reduced to stout, slightly incurved teeth. Petiole much shorter. Pronotum more heavily sculptured, finely longitudinally punctate-striate; mesonotum nearly smooth, shining. Pilosity, both on body and legs, much more abundant than in *contemta*. Brownish red, head darker red; apical half of gaster black; mandibles, antennæ and legs brownish yellow.

Nine specimens from Soochow (N. Gist Gee).

Crematogaster (*Acrocœlia*) *brunnea* subsp. *matsumurai* Forel var. *zoceënsis* Santschi.—Numerous workers from Tsingtau, Shantung (R. H. Lefevre).

This is evidently a Chinese variety of *matsumurai*, with decidedly longer epinotal spines, broader petiole and more distinctly divided postpetiolar tubercles.

Crematogaster (Acrocœlia) brunnea subsp. **ruginota** Forel var. **chungi,** new variety

WORKER.—Length, 2.5–3 mm.

Head very smooth and shining, longitudinally striated anteriorly. Pronotum and base of epinotum strongly longitudinally rugose; mesonotum concave behind, nearly smooth, shining. Epinotal spines reduced to stout, acute teeth, directed somewhat upward and slightly incurved. Petiole decidedly broader than long, its anterior border straight in the middle and obliquely truncated on each side, the sides distinctly dentate in the middle. Tubercles of postpetiole distinctly separated, finely striated and subopaque. Pilosity feebly developed, short and appressed on the scapes and legs. Castaneous brown; antennæ, thorax, petiole and legs paler, more reddish brown; tarsi yellowish.

Seven specimens from Foochow (H. H. Chung).

Crematogaster (Acrocœlia) brunnea subsp. **ruginota** var. **lefevrei,** new variety

WORKER.—At first sight closely resembling the preceding variety, but differing in the following characters: head broader in proportion to its length; thorax more shining, with much more delicate longitudinal rugæ on the pronotum, the mesonotum not concave posteriorly and anteriorly with a distinct median ridge, or carinula; the carinæ bounding the sides of the mesonotum distinctly dentate posteriorly; lateral angles of the petiole not dentate, the tubercles of the postpetiole much less sharply divided than in *chungi*. Pilosity on scapes and tibiæ more abundant and less appressed. Color very much like that of *chungi*.

Numerous workers from Tsingtau, Shantung (R. H. Lefevre); also several specimens taken in the same locality by N. Gist Gee.

This form was cited erroneously as subspecies *rabula* Forel in one of my previous papers. Superficially the varieties *chungi* and *lefevrei* are very similar to the variety *vagula* of Japan, but this form has a distinctly convex mesonotum, a more strongly impressed mesonotal suture, longer epinotal spines, and more rounded sides to the petiole. The varieties *vagula* and *formosæ* have much longer epinotal spines than any of the varieties above mentioned.

Monomorium minutum Mayr subsp. *chinense* Santschi.—Many workers from Foochow (H. H. Chung); three workers from Tsingtau, Shantung (R. H. Lefevre); three females and numerous workers from Peking (C. F. Wu), Laoshan Mts. near Tsingtau and six males from Shantung (A. P. Jacot).

This form is really a subspecies instead of a variety of *minutum*. Not only is the worker much darker than that of the European type, but the male and especially the female are quite distinct.

The female (undescribed) is wingless (ergatomorphic), like the subspecies *ergatogyna* Wheeler from California, and measures only 2.3–2.5 mm. (the female of the typical *minutum* is winged and measures 3.4–4 mm.). The thorax is much shorter and less elliptical, scarcely more than twice as long as broad, and much more narrowed in the epinotal region, with very small scutellum. In profile it is highest at the anterior end of the mesonotum whence it slopes gradually backward to the declivity of the epinotum. The pilosity is shorter and more even than in the typical *minutum*, the color darker, being black, like the worker, with the mandibles, antennæ, except their clubs, the knees, and tarsi reddish brown.

The male (undescribed) measures 2.3–2.6 mm. and is therefore smaller than the male of typical *minutum*, which measures 3–4 mm. The thorax is distinctly broader and stouter through the mesonotum. The color of the body and wings is like that of typical *minutum*.

Monomorium pharaonis L.—A single deälated female from Soochow (C. F. Wu).

Solenopsis fugax Latreille.—One worker, which seems to belong to this palearctic form, from Foochow (H. H. Chung).

Solenopsis indagatrix Wheeler.—Numerous workers from Tsingtau, Shantung (R. H. Lefevre) and three from Peking (C. F. Wu).

Solenopsis jacoti Wheeler.—Numerous workers from Weihsien, Shantung (R. H. Lefevre).

Solenopsis soochowensis Wheeler var. *pieli* Santschi.—One worker from Foochow (H. H. Chung) seems to belong to this variety, judging from the length of the antennal scapes.

Pheidòlogeton diversus Jerdon.—Numerous large and small workers from Hongkong (R. H. Lefevre) and one worker media from Foochow (H. H. Chung). They may represent some subspecies or variety of *diversus* but owing to the absence of soldiers more accurate identification is impossible.

Leptothorax congruus var. **wui,** new variety

WORKER.—Much like the typical *congruus* and with epinotal teeth of the same length, but the sculpture of the head is feebler, with the occipital border and middle of the front smoother and more shining. Legs paler yellow, the tibiæ and clubs of the antennæ not infuscated. In this character the specimens resemble the Japanese variety *spinosior* Forel.

FEMALE.—Differing from the female of *congruus* in having the nodes of the petiole and postpetiole smoother and shining above. The antennæ and legs are colored as in the worker; the wings are whitish hyaline, with very pale yellowish veins and pterostigma.

MALE.—Very similar to the male of the typical *congruus* but the thoracic dorsum is smoother and more shining and the femora and tibiæ are not infuscated in the middle. Coloration of wings as in the female.

Described from three workers, three females and four males from Peking (C. F. Wu).

Leptothorax eburneipes Wheeler.—This form should rank as an independent species. The thorax of the worker is much shorter and anteriorly higher and more convex than in *congruus* or any of its varieties, the petiole and postpetiole are higher and differently shaped and the epinotal spines are much longer.

Leptothorax galeatus Wheeler.—A single worker from Peking (R. H. Lefevre).

Triglyphothrix lanuginosa Mayr.—Numerous workers and a female from Hongkong (R. H. Lefevre). The former agree very closely with typical specimens in my collection from Java.

The female (undescribed) is very similar to the worker. It is slightly larger (2 mm.), with the head somewhat broader anteriorly and more rectangular. The epinotal spines are stouter at the base and the wings are long and colorless, with white veins and pterostigma.

Triglyphothrix striatidens Emery.—Numerous workers from Foochow (H. H. Chung).

Tetramorium cæspitum L. subsp. *jacoti* Wheeler.—Numerous workers from Peking (C. F. Wu), Tsingtau and Weihsien, Shantung (R. H. Lefevre).

Tetramorium cæspitum subsp. *jacoti* var. *geei* Wheeler.—Nine workers from Kiang-yin (N. Gist Gee) and one immature worker from Soochow (C. F. Wu).

Dolichoderinæ

Iridomyrmex itoi Forel.—Four workers of the typical Japanese form from Foochow (H. H. Chung).

Tapinoma geei Wheeler var. *tinctum* Wheeler.—Numerous workers from Tsingtau, Shantung (R. H. Lefevre) and Peking (C. F. Wu).

Tapinoma (Micromyrma) melanocephalum Fabricius.—Several workers from Hongkong (R. H. Lefevre) and Foochow (H. H. Chung).

Formicinæ

Plagiolepis manczshurica Ruzsky.—Numerous workers and females from Peking (C. F. Wu) and Peking, Soochow, and Tsingtau, Shantung (R. H. Lefevre).

As Santschi has shown, the worker of this species differs from the Mediterranean *pygmæa* Latrielle in the proportions of the third and fourth funicular joints, which are subequal and in the greater length of the first joint.

The female (undescribed) measures 3–4 mm. and averages smaller than the female *pygmæa* (3.5–4.5 mm.). It has the same proportions of the funicular joints as the worker and is black or dark brown, with the mandibles, scapes, first funicular joint and legs yellow, the femora often somewhat infuscated in the middle. The thorax seems to be slightly shorter and more broadly elliptical than in *pygmæa*. Wings grayish hyaline, with pale brown veins and pterostigma.

Camponotus japonicus Mayr var. *aterrimus* Emery.—Numerous workers, females and males from Peking and Soochow (C. F. Wu); workers from Peking, and Tsingtau and Weihsien, Shantung (R. H. Lefevre). Also many workers taken at Boketu and White River, Barum, Manchuria by P. H. and S. H. Dorsett.

Camponotus japonicus var. **miltotus,** new variety

WORKER MAJOR.—Resembling the variety *aterrimus* in pilosity but the pubescence on the gaster is even shorter. The cheeks and clypeus are bright red, the latter with a black longitudinal streak in the middle. Mandibles deep red with black teeth; scapes and legs brown, the femora darker; the funiculi black like the remainder of the body. Borders of gastric segments paler and more yellowish than in *aterrimus*.

A single specimen from Peking (C. F. Wu).

Camponotus japonicus wui, new subspecies

WORKER MEDIA.—Length, nearly 10 mm.

Petiole smaller, lower, narrower and with much less acute superior border and surface of body, especially the sides of the head, thorax and gaster, decidedly smoother and more shining than in the other forms of *japonicus*. Pubescence as in the variety *aterrimus*, long but sparser on the gaster than in the typical *japonicus*, sparse but distinct on the thorax. Hairs on the tibiæ very short but coarser, more numerous and more conspicuous than in *aterrimus*. Brownish black; clypeus and sides of head bright red; mandibles, antennæ, sides of pronotum and thoracic sutures dark red; legs, including coxæ, brownish red, the tibiæ and tarsi paler and more yellowish. Pale borders of gastric segments dull yellowish, twice as broad as in the other forms of *japonicus*.

A single specimen from Soochow (C. F. Wu).

It may represent a distinct species but the material is insufficient to determine its precise status.

Camponotus (*Tanæmyrmex*) *barbatus* Roger var. *albosparsus* Forel.—Six workers from Foochow (H. H. Chung) and one from Soochow (C. F. Wu).

Camponotus (*Tanæmyrmex*) *variegatus* F. Smith var. *mitis* F. Smith.—Numerous workers and males from Hongkong (R. H. Lefevre).

Camponotus (*Tanæmyrmex*) *variegatus* var. *dulcis* F. Smith.—One small worker from Hongkong (R. H. Lefevre).

Camponotus (*Myrmoserĭcus*) *rufoglaucus* Jerdon subsp. *paria* Emery.—Three workers from Hongkong (R. H. Lefevre).

Camponotus (*Myrmentoma*) *caryæ* Fitch var. *quadrinotatus* Forel.—A small worker from Soochow (C. F. Wu).

Polyrhachis lamellidens F. Smith.—Four workers from Soochow (C. F. Wu).

Paratrechina (*Nylanderia*) *flavipes* F. Smith.—Numerous workers and two females from Peking (C. F. Wu) and numerous workers from Tsingtau, Shantung (R. H. Lefevre). They agree in all respects with Japanese specimens.

Paratrechina (*Nylanderia*) *indica* Forel.—Numerous workers from Foochow (H. H. Chung) and Hongkong (R. H. Lefevre).

Lasius niger L.—Many workers, females and males from Weihsien, Shantung and numerous somewhat smaller workers from Tsingtau, Shantung (R. H. Lefevre); several workers and a deälated female from Peking (C. F. Wu).

Lasius (*Chthonolasius*) *flavus* De Geer.—Two deälated females and several small workers from Peking (C. F. Wu).

Formica fusca L. var. *japonica* Motsch.—Workers from Peitaiho, North China (N. Gist Gee), Tsingtau, Shantung (R. H. Lefevre), Peking (C. F. Wu) and White River, Barum, Manchuria (P. H. and S. H. Dorsett).

Formica rufibarbis Fabricius var. *glabridorsis* Santschi.—Numerous workers from Peking (C. F. Wu).

Formica rufibarbis var. *sinæ* Emery.—A dozen workers and a single deälated female from Peking (R. H. Lefevre).

The female (undescribed) measures nearly 8 mm. and closely resembles the female of the typical *rufibarbis*, but the dark bands on the mesonotum are larger and confluent. The superior border of the petiolar scale is deformed in the specimen but seems to be more convex and less transverse than in the European type.

Formica (Coptoformica) exsecta manchu, new subspecies

Worker.—Head more narrowed behind than in the typical *exsecta*, so that the distance between the posterior corners is decidedly shorter than the width of the head at its anterior corners. The occipital excision is therefore narrower though quite as deep as in the type. Clypeus more flattened, not carinate posteriorly. Maxillary palpi as long as in the type. Epinotum with more rounded and convex base, which is as long as the declivity and passing into it without a distinct angle. Petiolar scale much narrower above than in the typical *exsecta*, its sides nearly parallel, the excision of the superior border quite as sharp and deep, semicircular.

Body, especially the gaster, more opaque than in typical *exsecta*. Pilosity even less developed on the gaster. Color darker, the head black, except the cheeks, sides, gula and mandibles which are brownish red. The thorax, coxæ and petiole are also brownish red, but the spot on the pronotum is black and more extensive than in typical *exsecta*. Gaster black; antennæ and legs dark brown or in some specimens reddish brown.

Described from several specimens taken by Messrs. P. H. and S. H. Dorsett at Boketu, Manchuria.

Formica (*Proformica*) *jacoti* Wheeler.—Several workers and an immature female from Peking (C. F. Wu).

The female (undescribed) measures 6 mm. Head subrectangular, as broad as long, scarcely narrower in front than behind. Petiolar scale with straight, subparallel sides, its superior border somewhat more deeply and angularly excised than in the large worker. Pilosity longer and more abundant, especially on the gaster.

Formica (Proformica) lefevrei, new species

Worker.—Length, 4 mm.

Resembling *jacoti* but stouter, with shorter legs and antennæ. Head as broad as long, very slightly narrowed anteriorly, with broadly rounded posterior corners and straight posterior border. External borders of mandibles convex. Clypeus short and broad, indistinctly carinate, its anterior border not projecting, nearly straight. Frontal area not shining; frontal carinæ short and parallel; frontal groove distinct. Antennal scapes extending about one-fourth their length beyond the posterior corners of the head; first funicular joint slightly longer than the second and third joints together. Pronotum broader than long, convex and rounded, almost hemispherical when seen from above; mesonotum short, as long as broad, much narrower than the pronotum, in profile somewhat flattened above; mesoepinotal constriction distinctly shorter than in *jacoti* and the epinotum shorter, its base rising somewhat posteriorly, shorter than the sloping declivity with which it forms a distinct rounded angle. Petiolar scale much more compressed anteroposteriorly than in *jacoti*, so that it appears very thin in profile, its anterior surface feebly convex, its posterior surface flat, its superior border sharp in profile, broadly rounded when seen from the front, distinctly emarginate in the middle. Gaster rather large.

Shining, with æneous reflections; mandibles striatopunctate; clypeus, cheeks and front very delicately and longitudinally striate and sparsely punctate: posterior portion of head smooth and shining with small, sharp and moderately sparse punctures. Mesopleuræ and sides of epinotum rather opaque and granular; remainder of thorax and gaster smooth and shining.

Pilosity white, delicate, sparse and rather short on the upper surface of the body. Pubescence fine and appressed, visible only on the sides of the thorax, coxæ, petiole and appendages.

Black; pro- and mesonotum castaneous; mandibles, antennæ, trochanters, knees, tibiæ and tarsi yellowish red.

A single specimen from Tsingtau, Shantung (R. H. Lefevre).

The structure of the petiolar scale is peculiar and quite unlike that of *mongolica* Emery, *jacoti* Wheeler, *nasuta* Nylander, etc.

Cataglyphis cursor Fonsc. subsp. *rockingeri* Forel.—Numerous workers from Weihsien, Shantung (R. H. Lefevre), varying from 5–7 mm. in length. They agree perfectly with Forel's description of the types from Tian Shan, Turkestan. The occurrence of this form in Shangtung extends the eastward distribution of *cursor*, which ranges westward across the dry portions of Asia and Europe as far as southern France.

AMERICAN MUSEUM NOVITATES

Number 362

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

July 27, 1929

59 79 E:15.6

THE RELATION OF COURTSHIP TO THE SECONDARY SEXUAL CHARACTERS OF THE TWO-LINED SALAMANDER, *EURYCEA BISLINEATA* (GREEN)

BY G. K. NOBLE

From October to May, and possibly longer, the adult male two-lined salamander, *Eurycea bislineata bislineata* (Green), may be distinguished from the female by its markedly larger head (Fig. 1), glandular area on the chin, and scattering of yellowish or white glands on the lower eyelid, posterior part of upper eyelid and jaws, as well as on temporal region and neck. There is also a difference in the shape of the snout, lips and body. It has not been pointed out previously that the

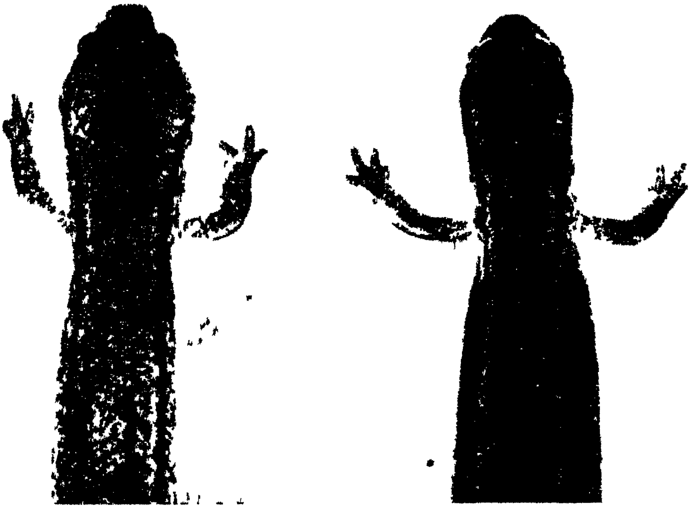

Fig. 1 *Eurycea bislineata bislineata*, male (left) and female (right), showing different head proportions in a courting pair.

adult males during this period have elongate monocuspid teeth in both jaws, the premaxillary teeth being directed slightly forward, while the females have shorter bicuspid teeth in both jaws. Adult *Eurycea melanopleura* show a similar sexual dimorphism of dentition during the fall but not in July. Possibly all species of *Eurycea* will be found to undergo an annual change of dentition in the adult male from bicuspid to monocuspid teeth and the reverse, but it has been established that the marked sexual dimorphism of *Desmognathus f. fuscus* and *D. f. carolinensis* is permanent throughout the year (Noble and Pope, in press). Correlated with the differences of head form and teeth size there are sexual differences in the elements of the skull.

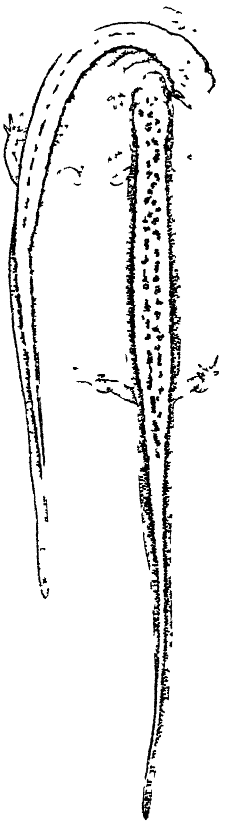

Fig. 2. The courtship of *Eurycea bislineata*. The male with temporal region pressed against the snout of the female.

From January to April, 1929, many males of *Eurycea bislineata* displayed during the evening a courtship activity in a series of covered crystalizing dishes half filled with water. The period is initiated by an awakening interest of the males in each other and in the females. The males push every salamander in their vicinity with their snouts, but show a continued interest only in the females. The latter are at first passive and allow themselves to be pushed about for short distances. The males nose any part of the female's body and often lift the female up by pushing their snouts under the cloaca or chest. The sexes rub snouts and cheeks, but the most distinctive pose is a sharp bending of the male's head around the snout of the female, reminding one greatly of the head pose of newts, *Triturus viridescens*, in amplexus (Fig. 2).

The second phase of the courtship may begin after an hour of the male's activity but it usually occurs later. The female, which either through her own activity or that of the male, has her snout pressed against his temporal region or his side, slips posteriorly and on reaching his hind limbs straddles his tail with her forelimbs. Her chin is brought close against the base of his tail at a point about a centimeter or more from the legs. This point is immediately posterior to the highest point of his tail. When the female's chin touches his tail, the male steps forward wagging the base of his tail sharply to right and to left. At every bend the female turns her head sharply in the opposite direction. The pair continue their walk about the aquarium, the grotesque wagging of the male's tail contrasting to the ordinary movements of the tail during locomotion in the other salamanders. If other males are prevented from nosing the pair the walk may continue with short interruptions for over an hour (Fig. 3). If a female loses her position she will regain it and continue the straddle walk without a preliminary thrusting of her snout against the body of the male

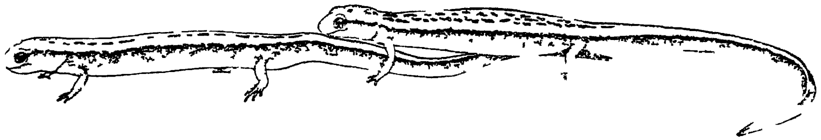

Fig 3. The courtship of *Eurycea bislineata* The female straddling the tail of the male, presses her chin against the tail base Hedonic glands are present in the skin of the male, apparently serving as the source of attraction

On April 3, four females and five males which had been actively courting during the evening were allowed to remain over night in the observation dish. The next morning two stalked spermatophores were found floating on the surface. Whether or not they had been torn loose from the glass bottom of the aquarium after deposition could not be determined. The spermatophores resembled closely those of *Desmognathus fuscus* as described by Noble and Weber (1929, Amer. Mus. Novit No. 351), but the base was truncated obliquely to the vertical axis, and the head was longer (Fig. 4). No spermatophores were found within the cloacas of the females although Noble and Weber have shown that these are regularly carried within the cloacal lips of the female from October to February.

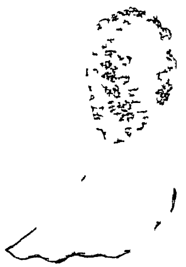

Fig. 4 The spermatophore of *Eurycea b. bislineata*, × 20

How the male *Eurycea bislineata* recognizes the female is not clear from these observations, but it is obvious that differential behavior of the two sexes plays a part in both phases of the courtship. The head, body, and particularly the tail base of the male is a distinct source of attraction for the female. An examination of the integument of these regions in serial sections has revealed a distinctive type of gland which has not been previously described from these parts of the body. This gland is distinguished from poison glands in *Eurycea bislineata* by having a central lumen and tall columnar cells. The cytoplasm is finely granular or pasty but never coarsely granular. It stains in Mallory's a bluish purple not reddish purple to red as the secretion of the poison glands. These new glands, which may be called hedonic glands, differ from mucous glands in never having a stringy or flocculent secretion or a homogeneous cytoplasm. They stain pink in hematoxylin and eosin, not blue as the mucous glands. They are usually larger than mucous glands but readily distinguished at all sizes except during the early growth stages.

The hedonic glands are very large on the dorsum of the tail base in *Eurycea bislineata* but they are not visible here in the living animal, nor usually distinguishable on the sides of the body, nor on the legs where they also occur. The whitish glands on the eyelids and in the temporal region of the male, when examined microscopically, are found to be hedonic glands. Sections show that no such glands occur in the female anywhere on the head, body or tail. The mental gland of the male appears to be a mass of hypertrophied hedonic glands although they are slightly translucent, not yellowish white, as the larger hedonic glands on the head are. The temporal glands of the male newt differ in some detail from the hedonic glands of *Eurycea bislineata* but there is some histological evidence that these glands are homologous structures.

Hedonic glands of the type found in *Eurycea bislineata* are of general occurrence in the Plethodontidæ, and homologous structures seem to occur in the Salamandridæ. They appear as visible structures on the lower eyelids of the male *Desmognathus f. fuscus* and *D. f. carolinensis.* They form a small but distinct dorsal protuberance at the base of the tail of the male *Eurycea multiplicata.* This glandular mass develops even in the male larva of the latter species before metamorphosis and is proably homologous with the less glandular tail spine of *Salamandra caucasica.* The enlarged glands scattered over the head and body of the male *Typhlomolge* have been found to be hedonic glands. Usually the hedonic glands are not visible except for the hypertrophied mass which forms the mental gland. I have found hedonic glands in the male *Desmognathus phoca, D. f. fuscus, D. f. carolinensis, Leurognathus m. intermedia, Plethodon cinereus, P. jordani, Hydromantes italicus,* as well as the species mentioned above. No glands were found in the integument of females of *D. quadra-maculatus, D. phoca, D. f. fuscus, D. f. carolinensis, P. cinereus,* or *Eurycea bislineata.* A detailed report on these glands is in preparation, but in the present instance it is important to emphasize their wide occurrence in male plethodontids for it would seem to follow that the method of courtship is similar throughout these forms. Only in *Aneides lugubris* and *A. æneus* have apparently homologous glands been found in both sexes. These glands are widely spread over the lower sides of body and ventral surfaces of both sexes and are readily visible in the living animal as yellowish spots. The histological differences between the larger of these glands and the hedonic glands of *Eurycea* will be given elsewhere; in the meantime, it may be pointed out that these glands of *Aneides* are neither poison nor mucous glands. It seems probable that they function in courtship or possibly in keeping the sexes together.

Lastly, it may be pointed out that although I have had more than fifty courting *Eurycea bislineata* in aquaria during the past months, and have frequently observed two or three males nosing the same female, I have never seen a male bite another individual or show any disposition to use his dagger teeth as weapons. Thus, while the hedonic glands are closely correlated with the courtship activities, and the forwardly directed premaxillary teeth may also serve as stimulating organs during the first period of courtship, the elongated maxillary and mandibular teeth seem to play no part in any phase of the process.

SUMMARY

1.—Courtship in *Eurycea bislineata bislineata* consists of two phases: during the first period the male noses the female and frequently presses his temporal region across her snout; during the second, the female presses her chin against his tail base while the pair walk about, the male wagging his tail base in a characteristic manner, and the female turning her head in the opposite direction at each bend.

2.—The spermatophore of *E. b. bislineata* is stalked and resembles that of *Desmognathus fuscus.*

3.—Hedonic glands are widely distributed over the sides of the head and body and over the dorsal surface of the tail and limbs of the male *E. b. bislineata.* Similar glands are found in the integument of all male plethodontids but absent from all females except *Aneides* where some may have a modified structure.

4.—The hedonic glands apparently serve as a source of stimulation and attraction to the female.

5.—The adult male *E. b. bislineata* has elongate monocuspid teeth in both jaws during fall, winter, and spring; the female, shorter bicuspid ones.

6.—The elongate maxillary and mandibular teeth apparently have no function in the courtship.

AMERICAN MUSEUM NOVITATES

Number 363 | Published by The American Museum of Natural History New York City | July 27, 1929

59 78 R.15 6

THE METHOD OF SEX RECOGNITION IN THE WOOD-FROG, *RANA SYLVATICA* LE CONTE

BY G. K. NOBLE AND E. J. FARRIS

In the preceding number of Novitates, one of us has presented evidence that the secretion of a distinctive type of integumental gland, restricted to the males of most plethodontid salamanders, functions in stimulating the female to sexual activity. It has been recorded (Wright and Allen, 1909) that the mere presence of the female *Ambystoma maculatum* in the tank with males was sufficient to stimulate the sexual interest of the latter. Whether or not the stimulating factor of *Ambystoma* is a chemical substance is not known. It seems certain from the work of Hilton (1902) and of Rogoff (1927) on the newt and from the observations on *Eurycea bislineata* reported in the previous paper, that a secretion from certain skin glands of the male of these salamanders plays an important rôle in their courtship. We have been interested in attempting to determine if similar secretions function in the courtship of frogs or toads.

Among the Salientia no hedonic glands have been described, and there is only one convincing account of a chemical sense as playing a part in sex recognition. Banta (1914) studied the mating of the wood-frog, *Rana sylvatica,* in the field and tested the reactions of males in a breeding colony to other individuals, male and female, attached to a fish-line. From these observations and experiments Banta concluded:

> The readiness with which the attempt of a male to pair with another male is given up on near approach, the keenness of the male's pursuit after once approaching very near or touching a female, the discrimination between a dead male and a dead female particularly in cases in which, to the human eye, the latter is indistinguishable in size, color and general features from a male, suggest that a chemical sense is involved in final sex recognition though one experiment designed to test this hypothesis was unsuccessful.

There is considerable difficulty in testing the reactions of frogs and toads in their native ponds. First, the animals under observation are always in danger of escaping. Secondly, other individuals may appear and be readily confused with the animal previously tested. Thirdly, one frequently is unable to approach close enough to observe details of behavior. We, therefore, decided to study the mating of the wood-frog under more controlled conditions with the view of determining the mechanism of sex recognition in this species. The study was undertaken as part of a more extensive investigation of the significance of secondary sexual characters in Amphibia.

METHODS

Breeding wood-frogs were collected in the local field and held in large tanks for further observations. The experiments were conducted in a dark room illuminated by a feeble red light. A tank 76.2 cm. long, 30.5 cm. wide, and 30.5, cm. high was half filled with water. Freshly captured specimens were tested in this tank and only the most vigorous used in the experiments. The injecting of the frogs was done with a Luer syringe provided with a long needle; and water was withdrawn from the body cavity with the same instrument. Care was taken to inject through the thigh muscles into the peritoneal cavity in order to avoid leakage when the needle was withdrawn.

PRELIMINARY OBSERVATIONS

Banta's account of the mating of the wood-frog has been critically reviewed by Cummins (1920) who, from observations of his own, fails to obtain any evidence of a precopulatory recognition. Miller (1909) had previously pointed out that toads are unable to distinguish the sexes at sight. The males grasp any individual within reach. If the individual seized is a male it chirps and is released; if it is a female it remains silent and is retained. Cummins concludes that sex recognition in the wood-frog results from a similar differential behavior of the sexes: "Males were found to clasp other males as well as females. Clasped normal males struggle, inflate the vocal sacs and croak, and are always released. Clasped females show usually brief and weak resistance and the clasp is nearly always retained."

In a series of preliminary experiments we definitely established that factors other than the warning croak play a very important part in sex recognition in the wood-frog. When a chloretonized male and female were offered alternately to active breeding males, both were clutched but only the female retained. As neither of the introduced frogs was capable of producing sound or movement it was clear that the breeding males were capable of distinguishing the sex in quiescent individuals as Banta had previously noted.

Hinsche (1926) has recently made a detailed study of sex recognition in the European toad, *Bufo vulgaris*. He found that males at the beginning of the breeding season change their mode of locomotion to more of a hopping gait. Males tend to seize companions walking or creeping near them more quickly than individuals hopping by. Hinsche stresses the importance of mutual excitement in a colony of breeding toads in calling forth the clasping reflex and, indeed, anyone who has witnessed a breeding colony of American toads or wood-frogs would conclude that this factor is operative in these species as well. Hinsche found that voice apparently plays little or no part in sex recognition in *Bufo vulgaris.* The shape and size of the female is of importance in permitting the male to maintain a firm hold; the roughness of the skin has a significance, but it is chiefly the vibrations of her flanks and the jolting movements of locomotion which stimulate the male to grip more firmly. This was demonstrated in *B. vulgaris*, by experiments, not only with living specimens, but also with models and inanimate objects. Male European toads will grip an agitated model longer than a stationary one.

In our preliminary examination of the problem of sex recognition of the wood-frog it became obvious that several factors influenced the rate at which the process was accomplished. There was evidence that the warning croak stressed by Cummins as well as the agitation factor emphasized by Hinsche both modified the length of the clutching reaction in the male frog. Fatigue was also found to hinder or even prevent the reaction entirely. Our experiments were, nevertheless, directed toward determining unknown factors in sex recognition rather than to working out the extent to which these additional factors might affect the result.

Our observations on the wood-frog were made from March 16 to 25, 1929. The first specimens were collected the night of March 16. We noted, as Banta had observed, that the females remain usually near the bottom of the pond; all the floating frogs were males. This difference of position in the water was very marked in the laboratory. Males introduced into the dark-room tank usually rose at once to the surface, and after a few swimming strokes sprawled out in the same characteristic floating attitude observed in the field. Females never assumed this spread-out attitude on the surface of the water. When rising for air they came up almost vertically. This inability of the female to float seemed to a large extent due to the weight of the eggs, or to the different extent of lung inflation. There was no marked difference in the size of their lungs.

Males are usually very active and frequently croak while bobbing up and down on the surface of the water. When two males strike each other one or both usually croak. Females are able to croak but their voices are not so loud as those of the males. When pinched in the leg the female will sometimes open its mouth and give a different sound which may be written, ye-ow.

In a series of experiments it was found that the male will hold tighter and longer to an active than to a chloretonized female. The active female never croaked when seized by a male, while a male clutched by one of his own sex usually croaked within a few seconds. Males released active males on many occasions when neither croaked, indicating clearly that males are able to recognize their own sex whether or not the warning croak is given. Of the several hundred cases of embrace witnessed in the laboratory, only twice did one male cling to another uninjected male over a minute. These may be considered cases of excessive excitement comparable to instances where a male will cling to the observer's finger after being separated from a female.

Throughout the series of experiments we could obtain no evidence of the male being able to distinguish between the sexes at a distance. On several occasions a female in the observation tank thrust her head above the surface near one or more active males without being perceived. Males varied enormously in the intensity of their ardor, but we could find no consistent difference in the rapidity with which they approached and embraced one of their own sex as compared with similar reaction toward a female.

Experiments with Wood-frogs

We noted in our preliminary observations that active males could readily distinguish between chloretonized male and female. That voice frequently played no part in sex recognition was obvious in those cases where a male rejected an active male without the latter croaking. In several of these cases the rejecting male was tested with a normal female and found to embrace in the usual vigorous way. Hence, the rejecting of the clutched male was not due to fatigue. In order to put the question of voice to an adequate test we performed a series of experiments in which the larynx of a male was incised in such a way as to prevent his making any sound. The reaction of the males toward this male did not differ from their reaction toward those still equipped with a voice.

Females of *Rana sylvatica* are usually larger than males and when burdened with eggs are usually distinctly stouter. This suggested that girth and particularly the difference in resistance to pressure between the bodies of the two sexes might be an important factor in sex recognition. We have tested this hypothesis by offering a chloretonized male to an active male, both before and after injecting the body cavity of the former with water in sufficient amounts to make the body resistant to compression. The experiment was repeated with different frogs on different days and always with fairly uniform results. The following experiment may be considered as typical of the series. It is more extensive than some of the experiments in that we began with a male and a female and later replaced the female by a male.

EXPERIMENT 1, MARCH 23

5:41 P. M.—Eggs were stripped from a female in embrace. After filling peritoneal cavity with approximately 7 cc. of water the female was offered to an active male which immediately seized her.

5:51—The pair which had been in active embrace, swimming about the aquarium for ten minutes, were forcibly separated.

5:58—Water withdrawn from peritoneal cavity of female. When latter was offered to male he seized her about head and let go.

5:59—Same female offered to same male in normal position. She was seized feebly and, as both sank to bottom of tank, was released within minute.

5:59:45—Chloretonized male offered to same male was seized and immediately released.

6·00—Same chloretonized male was injected with 7 cc. of water and offered to same male. The latter seized the former violently and attempted to slip forward to pectoral region. His efforts drove the pair forward along bottom of tank. In struggling for a pectoral grip the active male lost his hold but instead of rising to surface turned abruptly and swam to injected male lying quietly on bottom. The new grip was made again in the pelvic region and the struggle for a more anterior position continued.

6:06—Active male lost hold for second time in endeavoring to reach pectoral position. This time the struggling male rose to surface.

6:06:30—Injected male offered head foremost to the same active male was immediately seized and carried under the surface. While under water the active male turned abruptly around to face the same way as the injected male but in his efforts to grip abdomen of latter, he turned the injected partner over and secured a position with ventral surfaces opposed.

6:11—The same pair was still in embrace, with ventral surfaces together; the active male attempted several times to slide forward to the pectoral region of the injected specimen. Apparently the chloretonized male was too fully injected to make this possible.

6:13—Pair was swished about tank by hand, the active male still maintaining his ventral position. A vigorous push caused latter to lose position; he swam after other but came to surface before reaching goal. During this whole struggle the injected male was fully anesthetized and hence sound or movement could have played no part in arousing the activity of the embracing male.

6:17—The water was withdrawn from anesthetized male and the latter offered to the same active male. The now normal proportioned but inactive male was seized at once and carried to the bottom. On slipping forward to the pectoral region the active male made a few weak clutches and released his grip entirely one minute, thirty seconds after securing the first hold. It was clear that the chloretonized male in this condition did not interest the active male.

6:19—Same chloretonized male offered active male again with quicker results. The latter released grip in less than a minute.

6:20—Trial repeated; a grip in the pectoral region resulted in immediate release.

6:26—Same chloretonized male injected with 7 cc. of water. The same male which had just showed no interest in his impassive companion, seized the latter violently in the pelvic region and attempted to slide forward to the pectoral region. During this struggle on the bottom of the tank, the active male lost grip twice and each time swam back to companion. On the last struggle, the chloretonized male turned over and the active male gripped with ventral surfaces opposed.

6:29—While endeavoring to struggle forward to pectoral region, the active male lost grip but returned to the ventral surface.

6:30—Active male lost grip again while working forward to pectoral region and came to surface.

6:42—Same injected male offered to other in normal position. The latter gripped strongly.

6:43—Active male finally reached pectoral region in normal position but was still not satisfied, for he continued to make clutching movements.

6:52—After struggling for ten minutes under water to better his position, the active male lost grip and came to surface.

6:53—The water was withdrawn from the same chloretonized male, and the latter offered to the same active male. The chloretonized individual was seized several times but in each case released within a few seconds. Three offers were made head foremost with similar results.

6:55—The same chloretonized male was injected for the third time and again offered to the same male. The latter made two feeble attempts to seize the former but the third effort was with the same force as previously displayed towards the injected specimen. The gripping male paddled the pair half-way along the bottom of the tank endeavoring, as usual, to reach the pectoral region.

7:00—Active male reached about mid-region of chloretonized companion and still struggled.

7:01—In struggling the active male turned the chloretonized one over and gripped with ventral surfaces opposed.

7:02—Active male lost grip and rose to surface. The chloretonized male was found to be soft, indicating that the frequent needling had caused a leak and consequently uniform results could no longer be expected.

It is clear from this experiment and a series of others in which a chloretonized male was offered to an active one of the same sex that the girth and the resistance of the body embraced plays a very important rôle in maintaining the grip of the male. In these experiments we used the same pair for a series of trials during which the body of the chloretonized male was successively inflated with water, offered to the active male, deflated and offered again. Thus, we removed the voice factor, could control the agitation factor, and could show the importance of the size and resistance factor without any modifying influences other than fatigue. When using freshly captured males we found that fatigue did not seriously affect the results. The following experiment illustrates the extent to which a male wood-frog will retain its hold on one of its own sex if this should be of approximately the same girth and rigidity of abdomen as a female.

EXPERIMENT 2, MARCH 23–24

8:10 P. M.—Chloretonized male was offered to active male. Latter seized former and immediately released his grip.

8:14—Same chloretonized male injected with 7 cc. of water; again offered to the other male. The latter gripped and held firmly to the chloretonized specimen.

8:26—The pair which had been in embrace for twelve minutes were forcibly separated, the active male struggled vigorously to maintain his hold on his chloretonized companion.

8:30—Water was withdrawn from same chloretonized male and the latter offered to the same active male. It was held loosely for a few seconds and then released.

8:31—Four attempts made to induce the active male to seize the chloretonized one. In each case the active male grasped the other and released his hold within thirty seconds.

8:34—Same chloretonized male injected with 7 cc. of water and again offered to the same active male. The latter clutched the swollen male, and while uttering a number of low croaks, swam actively about the tank, maintaining a firm grip while doing so. The pair were lifted from the water several times by seizing the legs of the chloretonized male.

9:10—Same active male continued to embrace the chloretonized injected one for over half an hour without showing any tendency to release his grip. The pair were allowed to remain in embrace over night.

11 A. M.—(The following morning.) The pair apparently had been in embrace all night for the active male still held the injected one.

11:12—Water was withdrawn from same chloretonized male and the latter offered to the male which had been clutching him all night. The active male seized the chloretonized one at once but released his grip within thirty seconds.

11:13—Trial repeated with same result. The active male clutched the chloretonized one but maintained a loose grip for only a few seconds.

11:13:30—Trial repeated with the same results.

11:17—Same chloretonized male inflated by injection of 7 cc. of water intraperitoneally. When offered to the same active male it was seized at once and held firmly. With much struggling the active male attempted to work his way forward to the pectoral region of the injected one.

11:27—During the preceding ten minutes the active male reached approximately the mid-point of the injected one's body. The pair were lifted up from the water by holding the legs of the chloretonized male. The pair were then swished about the tank without the active male losing his grip.

Experiment then discontinued.

Records were made of experiments with nineteen different male wood-frogs in addition to those given above. If the embracing males were active we obtained very uniform results. Variations were obviously due in some cases to one or more of the modifying factors observed in our preliminary experiments. The following experiment is typical of a case in which the embracing males became fatigued or possibly frightened during some of the trials. Nevertheless, the experiment taken as a whole is convincing evidence of the importance of body size and firmness in sex recognition.

EXPERIMENT 3, MARCH 23

3:15 P. M.—Three active males offered a chloretonized male and female. They distinguished between them at the first trial, maintaining grip on the latter but not on the former.

3:21—The chloretonized male which had been refused was injected with 7 cc. of water and offered to first active male head foremost. It was seized at once and upon being allowed to float in the tank, was released and quickly seized in the normal direction but in the pelvic region. With a series of short clutches the embracing male attempted to slide forward to the pectoral region. In making one of these clutches the active male lost his grip and released the injected male.

3:26—Injected male was offered head foremost to second active male and was seized at once but released a minute later.

3:27—Same injected male was offered this active male in the normal position and was seized. Latter maintained his grip while swished about tank but released grip within a minute.

3:28—Trial repeated with same individuals but injected male, after being seized, allowed to float on surface of water.

3:30—Pair still in embrace were pushed about tank and frequently lifted from water.

3:35—Pair broken loose by a jerk.

3:35:30—The injected and chloretonized male was offered to the first active male again. It was seized but released a minute later.

3:37—Trial repeated but again first active male lost grip.

3:37:30—Trial repeated but injected male brought quickly against active male's body. The latter gripped and both sank to bottom of tank. The grip strengthened while the pair rose and sank in the tank.

3:42—Embracing male forcibly removed from injected male.

3:43—Injected male offered to the second active male again was seized at once about lower limbs. In attempting to change position two minutes later it lost grip.

3:56—The water was withdrawn from the peritoneal cavity of the chloretonized male, and the latter offered the two active males experimented with above. In three trials each, in both normal and reverse position, the active male seized and immediately released the chloretonized male. In one further trial the active male carried the chloretonized male to the bottom but released grip as both gradually rose to surface.

4:08—Chloretonized male injected again with 7 cc. of water. When offered to first active male it was seized and pushed to the bottom. The pair rose to the surface twice while the active male attempted to shift its grip to the pectoral region. Pair pushed about tank.

4:12—Male released grip while being pushed about tank.

4:15—Trial repeated but injected male offered head forward. It was seized but released a moment later.

4:16—Injected male offered to second active male in normal position. The latter seized the former violently and carried it about bottom of the tank, making some effort apparently to lift it to the surface.

4:21—Active male forcibly released from injected male and experiment discontinued.

It was pointed out above that females usually swim and remain near the bottom, coming up only at irregular intervals for air. We noticed in our experiments that the males usually held a firmer and longer embrace if they were kept below the surface. If the pair in embrace floats, the male, if fatigued, will frequently open his eyes, look around, weaken his grip, and finally release his hold entirely. The following experiment is typical of those in which the modifying influence of floating seemed to play a part.

Experiment 4, March 22

7:02 P. M.—Three active males which exhibited the normal embrace towards females were offered a chloretonized male and a chloretonized female held in the hand with heads directed toward them. Neither chloretonized animals showed any activity and of course did not croak, yet in every case the female was seized and held, the male clutched and released on the first trial.

7:10—The chloretonized male was injected with 5 cc. of water which made it puffy but not taut across the abdomen. Two of the active males seized the injected male and released it while the third gripped it tightly, was lifted clear of the water and later washed about tank without releasing his grip. Two minutes later a quick jerk caused this male to lose his grip.

7:15—Two additional cubic centimeters of water were injected intraperitoneally making the male fairly taut.

7:16—Injected male now offered to first active male was seized at once and lifted clear of water. The pair in embrace were then released and allowed to settle to bottom of tank.

7:26—Male which had held the injected male for nearly ten minutes at bottom of tank, was forcibly removed.

7:27—Injected male offered to second active male. The latter seized and maintained a hold for over a minute.

7:27:30—The same active male was then tested with another chloretonized male and a chloretonized female. It gripped both but maintained a hold only on the female.

7:30—The same active male was then offered the first injected male. It gripped and maintained a hold for over three minutes although the injected male was inactive and floated.

7:34—The same injected male offered to same active male and again he seized and swam with injected male to bottom of tank. The pair swished about tank, the embracing male strengthening his hold.

7:36—Pair being allowed to rest on surface for a few moments the embracing male's grip weakened and finally loosened.

7:37—Injected male offered to this second active male for the third time, but in this case with head foremost was immediately embraced. Pair swished about tank and finally anchored by one of the legs of the injected male to the bottom of the tank.

8:23—Male still maintained reverse position on back of injected male anchored to bottom of tank. For over forty minutes the male held this one position on his inactive companion.

8:24—Pair forcibly parted.

8:30—Same male which had been so long under water offered an uninjected chloretonized male and a similar female. It gripped and released the male, gripped and held tightly to the female. It was lifted out of water while maintaining grip on the latter.

8:31—Same male offered the injected male which it had previously held. It seized and held tightly to the latter while lifted free of water.

8:32—Grip broken loose and the chloretonized male and female as well as the injected male offered again. Reaction the same but weaker.

Experiment discontinued.

It was noticed in our preliminary observations that a male which has been clutching a female if forcibly separated will cling tenaciously to the observer's finger while an active male floating in the tank would never do this. It thus seemed that a prolonged embrace modified the reactions of one male toward another. We tested this proposition by a series of observations. The following experiment is one of those in which the effect of prolonged embrace apparently modified the expected result.

EXPERIMENT 5, MARCH 22

2:10 P. M.—Two males placed in tank and their reaction to a female containing eggs found normal. When female was held with head toward male she was quickly seized and held firmly, even though lifted free of water and shaken several times.

2:12—The pair were separated and female offered to second male, head on. She was quickly seized and together they swam about the tank, the female making efforts to escape.

2:14—Female succeeded in freeing herself of the male. Male held in hand and offered to other male induced a clutching reaction in the latter but the grip was immediately released. A second attempt also failed.

3:01—One of the males was injected intraperitoneally with 8 cc. of water, making it plump and nearly helpless in the water. It was offered head forward to the second male and was instantly seized. The pair were lifted out of the water by holding to the hind legs of the injected male. The pair were washed back and forth in the tank, the embracing male maintaining his grip and frequently croaking.

3:10—Pair lifted from water and embracing male forcibly removed from other.

3:14—The larynx of injected male incised after removing 5 cc. of water from the peritoneal cavity.

3:16—Voiceless male offered to other. It was seized and immediately released. Four more times the voiceless male was offered and each time seized and released.

3:21—Voiceless male with 3 cc. of water still in its peritoneal cavity was offered to a second male which had been grasping a normal female for over half an hour previously. Voiceless male seized and held until 3:48 P. M., when the experiment was discontinued.

THE RELEASE OF THE FEMALE AFTER EGG LAYING

It seemed to us highly probable that if the presence of eggs within the body of the female played such an important part in the process of sex recognition in *Rana sylvatica*, as we have demonstrated above, the absence of eggs in the body of the spent female was the immediate cause for the male releasing his embrace after egg laying. Spent females would not be distinguished from males by the active individuals of the latter sex and hence would not be mobbed while they were attempting to leave the pond. Wright (1914, p. 7) records a case of a wood-frog maintaining an amplexus after ovulation. This abnormal behavior was possibly due to excessive ardor. The male was not tested in its reaction to other individuals. There is no doubt that most male Salientia release the female a short time after egg laying. We have tested the question of the importance of body size in the release after egg laying by a series of experiments which gave very similar results. The following experiment may be considered typical of the series.

EXPERIMENT 6, MARCH 22

1:10 P. M.—Eggs removed by stripping from a breeding female. The latter then offered to an active male which seized her and released her immediately. Same female offered to a second active male which slipped with half-closed arms to the waist of the female. Within a minute the female had freed herself, the male making no effort to hold her. The same female offered to a third active male which gripped and released hold at once.

1:20—Female injected with 7 cc. of water was offered to the first male which seized her vigorously and maintained a grip while the female swam actively about the tank. The second male attacked the pair but was driven off by the first male which croaked loudly and struck out vigorously with his legs.

1:30—After ten minutes of embrace the pair was forcibly separated. During most of this period the pair had been swimming actively below the surface, the male maintaining a strong grip.

1:30:30—Water withdrawn from peritoneal cavity of the female with a syringe. When the female was now offered to the first male she was seized but released at once. Three consecutive attempts to induce the male to maintain a hold on the female in her present condition was without success.

1:37—Female injected again with 7 cc. of water. She was then offered to the same male which clutched and held firmly to her body.

1:52—The pair which had been actively swimming in the tank for nearly fifteen minutes were forcibly separated.

1:55—Water withdrawn from the same female and the latter offered to the same male. Each time the female's body was brought under him he seized her but released grip within a few seconds.

1:57—Same female injected for the third time and offered to the same male. Again he actively clutched her and maintained a vigorous hold.

2:07—Water withdrawn from female for the third time. When the female was offered to the same male he again made no attempt to maintain a grip. Female offered in various positions but without success.

2:11—Female injected with water for the fourth time was again grasped by the active male and held firmly.

2:22—The pair which had been in embrace for ten minutes were forcibly separated and the water withdrawn. When the deflated female was offered to the same male he behaved as on previous occasions. In no trial did he hold the female more than a few seconds.

2:26—Same female inflated with water for the fifth time. Same male vigorously clutched and maintained hold.

2:31—For some unknown reason the male suddenly dropped the inflated female.

2:32—When the inflated female was offered again to this male he seized her and maintained the usual vigorous grip.

2:40—Pair separated and water withdrawn from the female for the fifth time and again when the female was offered to the same male he gripped weakly and released hold at once.

2:44—Same female inflated with water for the sixth time, and same male seized her vigorously.

Experiment was discontinued at this point, the male having seized the female inflated with water six different times and refused her when deflated even a greater number of times because each attempt to make the male seize the deflated female consisted of several trials.

In some of the experiments it was clear that modifying influences could enormously affect the uniformity of the results. The following experiment is typical of those in which one of the males soon failed to respond, probably because of fatigue.

EXPERIMENT 7, MARCH 22

3:15 P. M.—A female which had just laid its eggs was offered to two males which had been embracing females with eggs for a half hour previously. The female was offered four times to each male. In every case the male gripped but released his hold within a few seconds.

4:08—The female was injected intraperitoneally with 8 cc. of water. When offered to one of the same males it was seized at once. The pair were washed about the tank and frequently lifted out of the tank, the male maintaining his hold continuously.

4:18—An especially vigorous swing of the pair in mid-air over the tank dislodged the male.

4:19—Injected female offered to other male previously tested. Male seized the female which now showed no activity.

4:21—Injected female now held as a dead weight in male's arms was released.

4:22—Injected female offered to same male was held as a dead weight for two minutes more and then released.

4:25—A normal female containing eggs was offered to this male but the latter made no attempt to seize it.

4:25:30—A second attempt and the male seized the active female which swam quickly about the tank, the male maintaining his grip.

4:26—Injected and quiescent female was offered to the first of the two males and was seized. Pair pushed gently around tank, the male strengthening his grip.

4:30—The pair allowed to remain without movement in the tank.

5:05—The male still maintained his grip on the injected and quiescent female.

5:25—Male forcibly removed from injected female and the water withdrawn from peritoneal cavity of latter.

5:28—Six times the same female was offered to the same male; every time the latter gripped and released hold either at once or within a few seconds.

5:30—Same female offered to a male which had been gripping a normal female containing eggs for over half an hour. Male seized and maintained a feeble hold for nearly two minutes when the female was dropped.

5:32—Same female offered to this male. The latter made a few feeble grips and finally refused to react at all.

EXPERIMENTS WITH EXTRASPECIFIC AMPLEXUS

It is well known that male wood-frogs will embrace other species of frogs. Wright (1914) mentions several cases which came under his observation. Cummins (1920) reports wood-frogs embracing a female leopard-frog and a female *Ambystoma maculatum*. He concludes: "In the light of extraspecific pairing (No. 5 and No. 10) it seems absurd to attribute any rôle of sight in sex recognition either on a basis of color or behavior." In view of the preceding experiments the question arose: Were these cases of prolonged extraspecific embrace reported by Wright and by Cummins due to the fact that the object clutched had the proper girth and firmness of body or were they not due merely to excessive ardor on the part of the embracing male? We have tested this question by a series of experiments.

(*a*) EXPERIMENTS WITH *Ambystoma*.—Two active specimens of *Ambystoma maculatum* were offered to a series of active male wood-frogs. One of the Ambystomas was fresh from the field and was swollen with eggs. The other was a female of the same length but it had been kept in an aquarium all winter and was slimmer than the other. The first female was held half an hour on the first test and was finally removed forcibly from the wood-frog. Tests with the other males were not as effective but we recorded three fifteen and one twenty minute embrace for these other males. The slim *Ambystoma* was as active as the plumper one but none of the male wood-frogs would retain a grip on this individual for over a few seconds.

(*b*) EXPERIMENTS WITH MECHANICAL DEVICES.—A series of objects were offered March 21, to the active males after they had been tested with chloretonized male and a female wood-frog to make sure that no modifying factors were influencing their ability to discriminate. A thin rubber finger cover when blown up with water until it was approximately the size of a female wood-frog, was seized and held for nine minutes. During this period the male clutching to the dummy was lifted several times from the water. It was found in the preliminary experiments that lifting the object embraced, out of water, was a critical test, for males never held to chloretonized uninjected males lifted out of water while they almost invariably maintained their grip on females similarly manipulated.

Attempts to repeat this experiment with rubber balls, pieces of rubber tubing and other devices gave no consistent results. Apparently the shape of the object was of some significance in sex recognition.

The importance of shape was brought to light many times in the other experiments. If a female is offered to the male head foremost he will seize her at once but eventually turn abruptly around under water to the normal position. Again we succeeded in one case of injecting 12 cc. of water intraperitoneally and subcutaneously into a male wood-frog. Although this bloated creature was seized by several males none would retain a grip more than a few minutes.

(*c*) EXPERIMENTS WITH LEOPARD-FROG AND GREEN-FROG.—It seemed probable from the above experiments that a wood-frog might not be able to distinguish a male of a larger species from a female of its own kind. In a series of preliminary observations this suggestion gained considerable support. Thus we witnessed a male wood-frog clinging to the pelvic region of a male leopard-frog, *Rana pipiens*, for over an hour. During this period the leopard-frog croaked regularly every few seconds with very few interruptions. Males of both the leopard- and pond-frogs were very active and usually freed themselves of any wood-frog which chanced to embrace them. Females of these species when swimming in a tank, were also usually successful in avoiding the attack of a male wood-frog. Nevertheless, the firmness of the body of the male green-frog was apparently not adequate for the wood-frog's maintaining his grip in the pectoral region. The following experiment is one of several which gave similar results.

EXPERIMENT 8, MARCH 25

12:10 P. M.—A male green-frog was etherized and offered to two active male wood-frogs. Both clutched the green-frog and released hold immediately.

12:19—Three successive attempts to induce wood-frogs to maintain grip on the anesthetized male green-frog resulted in failure.

12:25—Same male green-frog injected with water until plump. When offered to the first of the males it was immediately seized and retained.

12:35—During the previous ten minutes the male wood-frog maintained a firm grip on the injected male green-frog, while the pair rested on the bottom of the tank. At this moment the pair were forcibly separated.

12:37—Water withdrawn from body of male green-frog and the latter offered to the same wood-frog again. He gripped green-frog and released hold within a minute.

12:40—Same male green-frog offered again to the same male wood-frog was seized vigorously. After a few struggles the wood-frog slipped to pelvic region and assumed a feeble grip. The green-frog was gently touched with a view to stimulating the reflex in the wood-frog but the latter immediately released grip entirely.

12:44—Trial repeated but the male wood-frog merely gripped and released hold.

12:45—Same male green-frog injected with water and offered to the same male was immediately seized and held firmly.

12:55—Male wood-frog continued to maintain firm embrace on the injected green-frog. The pair were pushed vigorously about the tank and finally allowed to rest quietly.

1:00—Male wood-frog still maintained grip on injected green-frog.

Experiment discontinued.

DISCUSSION

The above experiments demonstrate that a chemical sense plays no part in sex recognition in the wood-frog. Males clasp any individuals in their vicinity and sex recognition results from the different size and resistance to pressure afforded by the bodies of the two sexes before egg laying. Various factors may modify the result. The warning croak of the male when touched by another male seems to act as a secondary factor hastening the speed of recognition. Females in locomotion, particularly below the surface of the water are held usually more firmly than quiescent or floating ones. In repeating experiments with the same individuals, fatigue may intervene to prevent a duplication of the results. The observations made by Banta (1914) differ so widely from our results that we are forced to conclude that the modifying factors discussed above were responsible for this difference. We performed many more experiments than Banta and obtained fairly consistent results. When the modifying factors are eliminated as far as possible, the importance of body size and resistance in sex recognition becomes very evident. Our experiments show that the difference between the sexes in body size and firmness affords the most important basis for sex recognition.

It does not follow from these experiments that sex recognition throughout the Salientia is accomplished by use of the same sensory data. Long ago Goltz offered stuffed males of a European frog to other males but failed to obtain any clear demonstration of the importance of the size and resistance factor in sex recognition (Holmes, 1916). Very recently Lullies (1926) has shown that in *Rana esculenta* and *Rana temporaria* weak action currents of the embrace reflex are induced by the breathing movements of the female. When these impulses cease, following the death of the female, the clasp, if no other stimulus excites it, is soon loosened. Thus in these frogs and in the toad studied by Hinsche, the agitation factor recognized in various parts of our own experiments, seems to become of primary importance. Hinsche did not consider the size factor independent of other factors in *B. vulgaris* and it may be more important in this species than he assumes.

The male wood-frog is readily distinguished from the female during the breeding season by the convex margins to the webbing between the toes (Wright, 1914, Pl. III, fig. 1*a*). These hypertrophied webs might function in assisting their owner, floating on the surface, to make a quick plunge toward an approaching frog. In both our field and laboratory experiments we failed to note that the male thus equipped was more agile than the female, but as the female does not float, the relative speed of get-away from the normal sprawled position of the male could not be compared.

SUMMARY

1.—Sex recognition in the wood-frog, *Rana sylvatica*, is first accomplished after the embrace, the males retaining their grip on individuals having a certain girth and degree of firmness of body.

2.—A chemical sense plays no part in sex recognition but the warning croak of an embraced male may shorten, and the normal movements of an embraced individual may increase the time period of the embrace. Other modifying factors are fatigue, degree of sexual ardor, and retreat of pair below surface of the water.

3.—Males release females after egg laying for the same reason they release males which they happen to embrace. The body of both groups of individuals does not have the required girth or firmness to permit their continuing the embrace.

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AMERICAN MUSEUM NOVITATES

Number 364 | Published by The American Museum of Natural History New York City | July 29, 1929

59.82 (96)

BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. VIII[1]

NOTES ON BIRDS FROM THE SOLOMON ISLANDS

BY ERNST HARTERT

Pandion haliæetus cristatus (Vieillot)

Buteo cristatus VIEILLOT, 1816, 'Nouv. Dict. d'Hist. Nat.,' nouv. éd., IV, p. 481 (Australia, not Tasmania).

♂, ♀: Arnavon and Oua raha Islands; March and September, 1927.

Haliæëtus leucogaster (Gmelin)

Falco leucogaster GMELIN, 1788, 'Syst. Nat.,' I, pt. 1, p. 257 (no locality; restricted typical locality Australia, New South Wales).

♂, ♀, juv.: Vella Lavella and Arnavon Islands between Choiseul and Ysabel; September and November; Hamlin Coll.

No subspecies of this wide-spread species have hitherto been recognized, Mathews' "*Cuncuma leucogaster pallidus*" not being separable and no longer thought recognizable in 'The Birds of Australia,' V, p. 133 (1915), but upheld again, without any explanation, in 'Syst. Av. Australas.,' I, p. 254 (1927). In this list Mathews also enumerates a "*Cuncuma leucogaster oceanica*" Meyer and Wiglesworth, which he assigns to Celebes. There is, however, no valid reason for this action. Meyer and Wiglesworth did not mean to give the name "*Falco oceanica,*" but quoted it as of Temminck, under his Plate XLIX in his 'Planches Coloriées,' by some error, as Temminck called it only by a French name, "Aigle océanique," nor is there any conceivable reason to retrict that name to an imaginary Celebes subspecies.

This species is often called "*Cuncuma leucogaster,*" but without giving convincing reasons. If *H. leucogaster* was separated generically, the same must be done with *pelagicus* and *leucoryphus*.

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[1] Previous papers in this series comprise American Museum Novitates, Nos. 115, 124, 149, 322, 337, 350, and 356.

Aviceda subcristata gurneyi (Ramsay)

Baza gurneyi Ramsay, 1880, Journ. Linn. Soc. London, XVI, p. 130 (Ugi Island, Solomon Islands).

Specimens from Ysabel, Bougainville, and Guadalcanar. Also one from Oua raha near San Cristobal (Bauro). This latter one has the underside unbarred, with only three narrow bars on each side on the chest. There is great individual variation in the barring, even in adults, though younger birds have narrower bars, but it is not known that the underside is sometimes quite unbarred. I know of no specimens from Bauro, and it is possible that an almost unbarred form of this bird exists there, but probably the specimen from Oua raha is an individual aberration.

The females are usually larger than the males, but this is not borne out by the sexing on all these skins, and the bird from Ysabel, sexed as a male, should in my opinion be a female.

I can see no valid reason why the eastern "Bazas" should be generically separated from *Aviceda*.

Haliastur indus girrenera (Vieillot)[1]

Haliastur girrenera Vieillot (and Oudart), 1825, 'Gal. Ois.,' I, p. 31, Pl. x, part (India and Australia. Restricted typical locality, Australia).

2 ♂, 1 ♀ ad., 1 ♀ juv.: Guadalcanar; April and June; Hicks Coll.

Mathews, in 'Syst. Av. Australas.,' I, p. 255 (1927), has given a list which seems to me misleading. He continues to call the Australian form *leucosternus* and distinguishes also a *subleucosternus*, which he restricts to Northern and Western Australia, but which is not separable. The form from "Celebes and Malay Archipelago" he calls *ambiguus*, but the name *intermedius* Gurney, Ibis, 1865, p. 28 (Java), is ten years older than *ambiguus*. There is in all these forms some variation; in fact, one of the Guadalcanar skins has narrow stripes, almost like *intermedius*, but the three races (*H. indus indus* (Boddaert) with wide stripes, from India; *H. indus intermedius* Gurney, from Java and Celebes to the Lesser Sunda Islands, with narrow stripes; and *H. indus girrenera*, usually without black lines) are well-marked in series.

Accipiter luteoschistaceus Rothschild and Hartert ? subspecies

Accipiter luteoschistaceus Rothschild and Hartert, 1926, Bull. B. O. Club, XLVI, p. 53 (Talasea, New Britain).

A young male was obtained by David at Vella Lavella Island, November 9, 1927. This bird seems to be a young of *Accipiter luteoschista-*

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[1] Mr. Mathews rejected Vieillot's name *girrenera* and calls this form *leucosternus*, but there is no valid reason to reject *girrenera*, as explained in Nov. Zoöl., 1914, XXI, p. 210.

ceus, discovered by Eichhorn on New Britain, and of which we know only the two adult males, though it has since been rediscovered by Father Meyer. The upperside of this young bird is slaty brown with dull rufous edges to the feathers and concealed white bases. Side of head with narrow white streaks. Quills blackish brown, inner webs toward the base pale reddish cinnamon with blackish bars, and blackish toward the shaft. Underside creamy white, darker and more ochraceous-buff on belly and under tail-coverts, and brightest on the thighs. Chin, throat, and chest with blackish shaft-lines, sides and flanks with ochraceous spots. Under wing-coverts ochraceous-buff. Cere (in skin) orange-yellow. Bill somewhat wrongly described on label as "yellow, tip black," the cere only being yellow, the hard portion of the bill being entirely black. "Feet yellow." Testes small. Wing, 190 mm.

This bird probably belongs to a subspecies of *A. luteoschistaceus*, but this cannot be proven until we have specimens of old birds from the Solomon Islands.

Accipiter albogularis Gray

Accipiter albogularis GRAY, 1870, Ann. and Mag. Nat. Hist., (4) V, p. 327 (San Cristobal).

Astur holomelas SHARPE, 1888, Proc. Zool. Soc. London, p. 182, (Guadalcanar. The melanistic variety).

Astur woodfordi SHARPE, 1888, Proc. Zool. Soc. London, p. 183 (Guadalcanar. Was specifically separated from *albogularis* because it had a vinous collar on the upperside).

Astur versicolor RAMSAY, 1882, Proc. Linn. Soc. N. S. Wales, VI, p. 718 (Ugi, near San Cristobal. Suggested in the description that it may be a melanistic *albogularis*).

2 ♀, ad.: Guadalcanar, June 2, 1927, R. H. Beck Coll.; Bougainville, January 25, 1928, Hamlin Coll. Both have the vinous-rufous collar on the upperside well developed.

♂ ad.: Fauro Island, December 1, 1927, R. H. Beck Coll. In this specimen the nuchal collar is duller and less visible.

♂, ad.: Bougainville; January 5, 1928, Richards Coll. This is a melanistic variety, being slate color all over, only the inner webs of the primaries and secondaries being more or less whitish.

In all these birds the iris is yellow or orange, and the cere (in skins) dull blackish or slate, while in the group of *pulchellus, bougainvillei, rufoschistaceus,* and *rubianæ* the iris is brown, while the cere is yellow. The development of the rufous nuchal collar varies very much. Cf. Nov. Zoöl., 1905, p. 249.

The Tring Museum had received this form from Guadalcanar, Choiseul, Kulambangra, New Georgia; also young ones, which vary much, but apparently belong to this form, from Vella Lavella, Rendova, and Treasury Island.

Accipiter (novæhollandiæ) rufoschistaceus (Rothschild and Hartert)

Astur rufoschistaceus ROTHSCHILD AND HARTERT, 1902, Nov. Zoöl., IX, p. 590 (Ysabel Island).

♂, ♀, ad.: Ysabel; August, 1927; Drowne and Hicks Coll.

The hawks of this group are particularly interesting, because they are very local. It will be useful to review them hereafter. Dr. Stresemann considers them all to be subspecies of *A. novæhollandiæ*, and a thorough study of all these forms leads to that view, of which I thoroughly approve. As American ornithologists have not advanced to this wide view of species and subspecies, and would doubtless name *novæhollandiæ* and the Solomon Islands' group binomially, I have, therefore, placed the specific name, *novæhollandiæ*, in parenthesis, in order to call attention to possible different views.

The four hawks of this group, from the Solomon Islands, are as follows.

(*a*) **Accipiter (novæhollandiæ) pulchellus** Ramsay

Astur pulchellus[1] RAMSAY, 1883, Journ. Linn. Soc. London, XVI, p. 131 (Solomon Islands).

Astur shebæ SHARPE, 1888, Proc. Zoöl. Soc. London, p. 183 (Guadalcanar).

♂, ♀, ad.: Guadalcanar; May, 1927; Beck and Hicks Coll.

Distinguishable from the other forms by the paler, sometimes almost whitish thighs and more or less whitish under wing-coverts. Wings: ♂, 204, 206 mm.; ♀, about 220, 222 mm.

Meek sent only one specimen, a young bird, from Florida.

(*b*) **Accipiter (novæhollandiæ) bougainvillei** (Rothschild and Hartert)

Astur etorques bougainvillei ROTHSCHILD and HARTERT, 1905, Nov. Zoöl., XII, p. 251 (Bougainville Island).

Under wing-coverts and thighs the color of the breast and abdomen. Wings: ♂, 195 to 200 mm.; ♀, 212, 219 mm.

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[1] This is not "a new name for *A. soloënsis*" (!) but for a specimen erroneously named *soloënsis* by the author. It was said to be from "Cape Pitt, Solomon Islands," but the only Cape Pitt known is the Cape on New Georgia. The specimen called *pulchellus*, however, cannot be from New Georgia, but, from its description, must be from Guadalcanar. As the collector, Cockerell, has in other cases been careless about localities, I restrict the name *pulchellus* to the Guadalcanar form. Thus an alteration in the accepted nomenclature is avoided.

Bougainville (and, apparently, Fauro in the Shortland group, from which place a young bird was received).

(*c*) **Accipiter (novæhollandiæ) rufoschistaceus** (Rothschild and Hartert)

Astur etorques rufoschistaceus Rothschild and Hartert, 1902, Nov. Zool., IX, p. 590 (Ysabel Island).

Very similar to *bougainvillei* but larger and the coloration slightly deeper. Wings: ♂, 214, 215, 219, in one specimen 225 mm.; ♀, 240, 244, 250, 254 mm.

Ysabel and Choiseul Islands.

(*d*) **Accipiter (novæhollandiæ) rubianæ** (Rothschild and Hartert)

Astur etorques rubianæ Rothschild and Hartert, 1905, Nov. Zool., XII, p. 250 (Rubiana (New Georgia) group; New Georgia, Rendova, Gizo).

Slightly deeper in color still than *rufoschistaceus*, and much smaller, in size more like *pulchellus*, but under wing-coverts and thighs like the breast. Wings: ♂, about 192 (worn), 196, 199 mm.; ♀, 208 (worn), 211, 213, 215 mm.

The western central group: New Georgia, Rendova, Gizo, Vella Lavella Islands.

Accipiter meyerianus (Sharpe)

Astur meyerianus Sharpe, 1877, Journ. Linn. Soc. London, XIII, p. 458, Pl. xxii (Jobi Island).

♀, ad.: Kulambangra; September 29, 1927; F. P. Drowne Coll. "Iris reddish brown. Bill black, bluish, and yellow at base. Feet yellow. Sexual organ swollen." Wing, 322 mm.

This is the second specimen of this very rare species from the Solomon Islands. Another. in moult from the juvenal to the adult plumage, was obtained on Guadalcanar by Woodford and labeled "*Astur albigularis*." It is now in the British Museum. The distribution of this goshawk (considered by Kleinschmidt and Stresemann to be a subspecies of our *Accipiter gentilis = palumbarius*) is peculiar and it is strange that so few specimens are known. The reason is, perhaps, that much of the collecting in Papuan regions is done by natives, who are excellent collectors, but they cannot shoot flying birds—and goshawks are not easily shot! This species is now recorded from Jobi, Ceram, Ceramlaut, Vuatom, near New Britain, Halmahera, Guadalcanar, and Kulambangra, but it must occur in many other places. The bird from Vuatom was described by Reichenow as *Astur planes*, the one from

Ceram by Stresemann as *Accipiter planes maneho.* The latter is more heavily marked on the underside, and may possibly constitute a Moluccan subspecies, but there is not sufficient reason to suppose this.

Spiloglaux roseoaxillaris, new species

MALE.—Upperside rufous cinnamon, on the nape some small round light spots of a dull ochraceous-buff; quills rufous brown, inner webs darker and with a few white bars or roundish patches reaching across about the inner half of the web and not in all cases touching the inner margin, secondaries and inner primaries with roundish whitish spots on the outer webs, larger coverts also with a few whitish spots. Tail rufous brown like wings, inner webs with four to five irregular whitish cross-bars. Sides of face like back, on the throat, reaching up to the beak, a triangular white patch. Rest of underside cinnamon, lower abdomen, under tail-coverts and thighs lighter, sides of breast darker, the lower feathers with lighter, almost creamy cross-bars and spots. Axillaries pale pink, quills from underneath brown, crossed by irregular bars of white, which are tinged with pale pink toward the pale pink base; under wing-coverts light rufous. "Iris brown, bill horn, sexual organs small." Wing, 157; tail, 86; tarsus, 30; culmen from cere, 17 mm. The feathering of the tarsus is almost evanescent toward the toes which have a few bristles.

TYPE.—Male, adult; Bauro (San Cristobal); April 4, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 217087.

This is the only specimen of this most interesting and quite peculiar new species. Further researches must show whether this owl is restricted to San Cristobal or spread over various islands.

Spiloglaux jacquinoti jacquinoti (Bonaparte)

Athene jacquinoti BONAPARTE, 1850 'Consp. Gen. Av.,' I, p. 42, ('Oceanie,' ex Jacquinot, 'Voy. Pôle Sud.,' Pl. III, fig. 1).

Athene tæniata JACQUINOT AND PUCHERAN, 1853, 'Voy. Pôle Sud,' Zool., III, p. 50 (Saint George Island near Ysabel, Solomons. Based on the same bird which Bonaparte called *A. jacquinoti*).

♂, ♀: Florida Island; June 25, 1927; R. H. Beck Coll. ♂: Ysabel Island; August 24, 1927; David Coll.

These specimens agree with twelve collected on Ysabel by Meek and Eichhorn, and one from Florida shot by C. M. Woodford. There is a good deal of variation in these owls. The upperside is sometimes blacker, sometimes more rufous brown; the spots are more or less numerous; the central retrices are either barred or unbarred; the underside is whiter or browner, the bars on the sides of the breast are sometimes less distinct than usual. The wings of non-moulting specimens measure about 200–226 mm., the females being larger. Tails, about 106–120 mm.

The specimens from the northern islands, Bougainville, and Choiseul, fourteen of which I have before me, are smaller. The wings of unmoulting birds do not range up to 200 mm., being 185–197 mm., the tails. 10–15 mm. shorter. Bills slightly smaller.

This form might be distinguished from *S. j. jacquinoti* as *S. j. eichhorni.*

Spiloglaux jacquinoti eichhorni, new subspecies

TYPE.—Male, adult; Choiseul; December 10, 1903; No. A 900; A. S. Meek Coll.
HABITAT.—Bougainville, Choiseul, and Treasury Islands.

Spiloglaux granti (Sharpe)

Ninox granti SHARPE, 1888, Proc. Zool. Soc. London, p. 183 (Guadalcanar)

♂, ♀ : Guadalcanar; July 26–27, 1927; Beck and Hicks Coll.

The amount of pale spotting on the head varies much. The loral bristles are sometimes entirely black, sometimes white basally, with black distal portion.

Hylochelidon nigricans nigricans (Vieillot)

Hirundo nigricans VIEILLOT, 1817, 'Nouv. Dict. d'Hist. Nat.,' XIV, p. 523. (Australia).

1 ♂: Guadalcanar; May 19, 1927; Beck Coll.

This Australian swallow is a migrant from Australia. Though it has not previously been known to occur on the Solomon Islands, this record is not very strange, as it has been recorded from New Guinea and New Britain.

Hirundo (Hypurolepis) tahitica subfusca Gould

Hirundo subfusca[1] GOULD, 1856, Proc. Zool. Soc. London, p. 137 (Moala, Fiji Islands).

Guadalcanar; May, July; Drowne and Hicks Coll. Bauro; March 29, 1927; Kulambangra; October 17, 1927; Choiseul, November 28, 1927; Fauro, December 2, 1927; Hicks Coll. Oua raha near Bauro; March 14, 1927; F. P. Drowne Coll. Bagga Island; November 7, 1927; David Coll.

Meliarchus sclateri (Gray)

Philemon sclateri GRAY, 1870, Ann. and Mag. Nat. Hist., (4) V, p. 364 (San Cristobal).

3 ♂, 3 ♀ : Bauro (San Cristobal); March and April, 1927; Hicks, Beck, and Drowne Coll.

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[1] For a long time this bird has been called *Hirundo tahitica*, but it is very different from the Tahiti form

The wings of the males measure 133–138 mm.; of the adult females, 115–118 mm. The iris is described as straw-color, whitish, yellowish horn. Meek and Eichhorn called it gray.

GUADALCANARIA, new genus

This new bird belongs to the genus *Ptilotis* in its widest sense and is nearest to "*Meliphaga*" (*Ptilotis lewini*), having no naked space or wattles anywhere, but it has a longer bill and a tuft of yellow feathers on the sides of the neck, not behind the eye as in *M.* (*Trichodere*) *cockerelli*, and no bare skin-fold behind the gape as in *M.* (*Lichenostomus*) *cratitia*. It will therefore have to be treated as a new genus or subgenus.

TYPE.—*Guadalcanaria inexpectata.*

It certainly was unexpected to find such a striking and hitherto unknown species on Guadalcanar, and this and the discovery of other new forms on that island shows that the ornithological exploration of Guadalcanar has hitherto been very imperfect.

Guadalcanaria inexpectata, new species

ADULT MALE.—Bill black. Upperside slate-gray with a brownish tinge on the rump and upper tail-coverts. Quills slate-color, outer webs widely edged with greenish olive-yellow, inner webs with a narrow buff edge. Retrices brownish slate-color, outer webs edged like the wings. Ear-coverts glossy slaty gray. On the sides of the neck a tuft of pointed golden-yellow feathers, about 2 cm. long. Throat and foreneck grayish white with dark shaft-stripes, dark gray on the throat, blackish towards the breast. Breast and abdomen dark gray with blackish gray shaft-stripes, vent and under tail-coverts brownish gray, indistinctly striated. Under wing-coverts brownish gray, indistinctly striated. "Feet bluish, light bluish, gray, iris brown." Bill from forehead 31–32; wing, 104–111; metatarsus, 29–30; tail, 90–93 mm.

ADULT FEMALE.—Exactly like the male but smaller. Wing, 97, 98 mm.; bill, 27–28 mm.

TYPE.—Male adult; Guadalcanar; July 25, 1927; Mrs. R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 220323.

4 ♂, 2 ♀: Guadalcanar; July 25 and 27; Mr. and Mrs. R. H. Beck Coll.

Cinnyris jugularis flavigastra (Gould)

Nectarinia flavigastra GOULD, 1843, Proc. Zoöl. Soc. London, p. 104 (New Ireland).

1 ♂, 3 ♀: Guadalcanar; May, July. 2 ♂: Ysabel; August 29, 1927; Pavuvu, July 11, 1927; 1 ♀ (name of island unreadable on label); Drowne Coll. 1 ♂: Beagle Island; April 23, 1927; Hicks Coll. 1 ♂: Savo Island; June 4, 1927; Beck Coll.

Obviously, all the specimens from the Solomon and Bismarck archipelagos belong to the same form, the oldest name of which is *flavigastra* Gould.

Dicæum tristrami Sharpe

Dicæum tristrami SHARPE, 1883, Proc. Zool. Soc. London, p. 579 (San Cristobal); 1908, Nov. Zool., XV, p. 364 (San Cristobal).

3 ♂, 3 ♀: Bauro or San Cristobal; March and April, 1927.

Dicæum æneum Jacquinot and Pucheran

Dicæum æneum JACQUINOT AND PUCHERAN, 1853, 'Voy. Pôle Sud,' Text Zool., III, Ois., p. 97 (Ex Pl. XXII, fig. 4. "San Jorge").

"San Jorge" doubtless means St. George Island near Ysabel, and therefore the name *æneum* must belong to the smaller northern form. Specimens from Guadalcanar are slightly larger (wing, ♂, 52–54.5 mm.), and the sides of the body are a shade more olivaceous in both sexes. The species may therefore be divided into two subspecies as follows.

(*a*) **Dicæum æneum æneum** Jacquinot and Pucheran

Inhabiting Bougainville, Choiseul, Ysabel, and St. George's Island. Wing: ♂, 49.5 (in one specimen), 50–52; ♀, 45–48 mm.

1 ♂, 2 ♀: Choiseul; November, 1927; Drowne, Hicks, Coll. 1 ♂: Ysabel; August 23, 1927; Beck Coll.

(*b*) **Dicæum æneum becki,** new subspecies

Guadalcanar, Tulagi. Wing: ♂, 52–54.5; ♀, 48 (in one specimen) to 50 mm.

TYPE.—Male, adult; Guadalcanar; July 22, 1927; Hicks Coll.

1 ♀: Tulagi; May 23, 1927; Hicks Coll. 2 ♂, 1 ♀: Guadalcanar; May and July, 1927, Hicks and Drowne Coll.

Myzomela pammelæna tristrami Ramsay

(*Myzomela pammelæna* SCLATER, 1877, Proc. Zool. Soc. London, p. 553. Admiralty Islands).

Myzomela tristrami RAMSAY, 1882, Proc. Linn. Soc. N. S. Wales, VI, p. 178 ("Solomon Islands"). 1908, Nov. Zool., XV, p. 364, San Cristobal.

2 ♂, 1 ♀: Bauro or San Cristobal; March and April, 1927. 1 ♂, 2 ♀: Awa Kaba Island; March 9 and 11, 1927; Drowne and Hicks Coll.

The latter specimens may possibly form a larger race, the wings measuring (♂) 71–72 mm., while in the Bauro specimens, the males range only up to 69 and 70 mm., but more material is required to confirm this slight difference.

Myzomela eichhorni eichhorni Rothschild and Hartert

Myzomela eichhorni ROTHSCHILD AND HARTERT, 1901, Nov. Zool., p. 181 (Kulambangra).

♂, ♀: Kulambangra, October; 1927; Drowne and David Coll.

Myzomela eichhorni atrata Hartert

Myzomela eichhorni atrata HARTERT, 1908, Bull. B.O. Club, XXI, p. 105 (Vella Lavella).

♂, ♀: Vella Lavella; October, 1927; Beck and Drowne Coll.
♂, ♀: Ganonga Island; October, 1927; Drowne and David Coll

Myzomela melanocephala (Ramsay)

Cinnyris melanocephalus RAMSAY, 1897, Nature, XX, p. 125 ("Guadalcana" = Guadalcanar). According to Mathews, this publication appeared a few weeks before that of *C. dubia*.

Cinnyris (?) *dubia* RAMSAY, 1897, Proc. Linn. Soc. N.S. Wales, IV, p. 83 (Savo, a little island close to Guadalcanar). Cf. ROTHSCHILD AND HARTERT, 1901, Nov. Zoöl., p. 181.

1 ♀: Guadalcanar; April 20, 1927; R. H. Beck Coll.

Myzomela lafargei Jacquinot and Pucheran

Myzomela lafargei JACQUINOT AND PUCHERAN, 1853, 'Voy. Pôle Sud,' Zool., Ois., p. 98 (Solomon Islands); ROTHSCHILD AND HARTERT, 1902, Nov. Zool., p. 518 (Ysabel).

2 ♂, 2 ♀: Ysabel; August, 1927; Beck and Drowne Coll.
1 ♂: Choiseul; November 22, 1927; Drowne Coll.

Zosterops alberti alberti Rothschild and Hartert

Zosterops alberti ROTHSCHILD AND HARTERT, 1908, Nov. Zool., XV, p. 364 (San Cristobal Island)

1 ♂, ad.: Bauro = San Cristobal; April 8, 1927; R. H. Beck Coll.

The bird to be called *Z. ugiensis* (Ramsay), the *Z. salomonensis* of Finsch, 'Tierreich,' Lief. XV, 1901, p. 42, cannot be this form, as its description disagrees; Ramsay called it *Tephras* because its upperside was "uniform dull brown, washed with olive," and not green. Unfortunately, the little island of Ugi has thus far not been revisited by collectors. Although so near San Cristobal (Bauro), we know several different forms from Ugi.

Zosterops alberti oblita, new subspecies

Very much like *Z. a. alberti*, but the under tail-coverts are lemon yellow, lores and forehead like the back, not washed with dark brown. In *Z. a. alberti* the under tail-coverts are white, sometimes slightly washed with yellow. Wing: ♂, 69 mm. (one not quite measurable); ♀, 67–71.5 mm.

TYPE.—Male adult; Guadalcanar; May 30, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 218110.

2 ♂, 3 ♀: Guadalcanar; May and July, 1927; R. H. Beck and Hicks Coll.

Zosterops metcalfei metcalfei (Tristram)

Zosterops metcalfei TRISTRAM, 1894, Ibis, p. 29, Pl. III (Bugotu, Ysabel Island).

We had this widespread form from Bougainville, Choiseul, and Ysabel. There are now in the Whitney Expedition Collection two males and one female from Ysabel, and one male and two females from the Shortland Islands.

Zosterops metcalfei floridana Rothschild and Hartert

Zosterops floridana ROTHSCHILD AND HARTERT, 1901, Nov. Zool., VIII, p. 180, (Florida Island, Solomon Islands).

This form differs from *Z. metcalfei metcalfei* only in having no trace of the white orbital ring. In *Z. metcalfei metcalfei* that ring is always visible in cleanly prepared skins. In the series the upperside of *Z. m. floridana* is also a shade lighter. This is so obviously a subspecies of *metcalfei* that I have used trinomials for its denomination. In the other forms of *Zosterops* I have refrained from using trinomials, because it requires a thorough study of the genus to group them properly.

♂, ♀: Florida; May 26, 1927; Beck and Hicks Coll.

Zosterops kulambangræ Rothschild and Hartert

Zosterops kulambangræ ROTHSCHILD AND HARTERT, 1901, Nov. Zool., VIII, p. 180 (Kulambangra Island).

1 ♂, 2 ♀: Kulambangra; October 5 and 10, 1927; F. P. Drowne Coll.

These specimens agree perfectly with those formerly collected by Meek. Bill entirely black and quite narrow, in not very carefully prepared specimens, hardly visible white eye-ring, lores blackish.

Zosterops murphyi, new species

Bill black, basal half of under mandible "yellow" (whitish in skin). Eyes surrounded by a wide ring of white feathers, under the eye up to 2.5 mm. wide. Upperside green with a yellow tinge, underside much lighter. Bill, ♂, from base, 19; wing, 64–66; ♀, 63–63 2 mm.

TYPE.—Male, adult; Kulambangra; October 13, 1927; Hicks Coll.; Amer. Mus. Nat. Hist. No. 220087.

3 ♂, 2 ♀, from Kulambangra.

This *Zosterops* is named in honor of Doctor Robert Cushman Murphy, in charge of the Whitney Expedition, to whom we are all indebted for many courtesies.

It is interesting to find two species of *Zosterops* on the small island of Kulambangra. The Santa Cruz species is much larger and much paler.

Zosterops vellalavella Hartert

Zosterops vellalavella HARTERT, 1908, Bull. B. O. Club, XXI, p. 106 (Vella Lavella Island); 1908, Nov. Zool., p. 358.

2 ♂, 1 ♀, from Vella Lavella; ♂, ♀, Bagga Island, near Vella Lavella, all November, 1927; R. H. Beck and Hicks Coll.

Zosterops luteirostris Hartert

Zosterops luteirostris HARTERT, 1904, Bull. B. O. Club, XIV, p. 61 (Island of Gizo).

Four males from Gizo, October and November, 1927. Meek described the iris as dark red, but Beck called it brown, and Drowne named it reddish-brown and brown.

Zosterops splendida, new species

Forehead and lores black-brown, this color merging into the olive-yellow of the back, rump, upper tail-coverts and outer aspect of the wings; hidden portion of quills brownish black, inner edges white. A wide white ring around the eyes, narrowly interrupted in front. Underside from chin to under tail-coverts beautifully golden-yellow, sides of the breast pale olivaceous. Under wing-coverts lemon yellow. "Iris brown or orange, bill black, feet yellow." Sexual organs mostly enlarged. Male like female. Wing: ♂, 60–61.5; ♀, 51 mm. Bill, from base (forehead), 16–17 mm.

TYPE.—Male, adult; Island of Ganonga, Solomon Islands; October 24, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 220020.

Four males and one female of this beautiful bird were sent by R. H. Beck.

MOCHTHOPŒUS, new genus

This new bird reminds one at first glance of a *Phylloscopus* with a much stronger bill and somewhat short tail. At the gape are some short or moderate bristles; the nostrils are covered with an operculum, the pervious holes which one can see are evidently caused by threads being pulled through the nostrils. First primary about half of the second, fourth and fifth about equal and longest. No emarginations to the primaries. Tarsus covered by a lamina, which is broken up into scales only near the toes. Hind claw fairly strong, plumage soft.

TYPE.—*Mochthopœus amœnus.*

I believe that this peculiar new form is near to the genus *Phylloscopus.*

Mochthopœus amœnus, new species

Adult Male.—Upperside dark olive-brown, darker and almost blackish on the crown; there is an indistinct olive-yellow superciliary line, merely indicated; sides of head deep brown with dull yellow tips to the feathers. Quills blackish brown with narrow olive-yellow outer and yellowish flesh-colored inner margins. Greater series of upper wing-coverts with olive-yellowish tips. Tail uniform deep brown. Underside dull yellow, the feathers browner on the sides, causing a striped appearance. Sides olivaceous brown with a greenish tinge. Under wing-coverts brownish and yellow. Bill dark brown, lower mandible "yellowish" or "horn." "Iris brown. Feet grayish." Wing, 88.5—90; tail, 39; bill, 15; tarsus, 23 mm. A specimen marked "? ♀ " is in moult, apparently from the first juvenal plumage, which in phylloscopine birds does not differ much from that of the adults.

Type.—Adult; Kulambangra; October 11, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 220110.

A second male, shot the following day, when the moulting bird was obtained also, was sent. The testes of the two males were enlarged.

Phylloscopus trivirgatus becki, new subspecies

This new form, overlooked by former collectors on Guadalcanar, is surprisingly near to *P. t. everetti* Hartert, from Buru, but the breast and abdomen are paler, the sides of the head are a shade lighter, and perhaps the yellowish tips to the greater upper wing-coverts are usually narrower. "Iris brown, bill brownish black, lower mandible brown, paler toward the base. Feet gray." Wing: ♂, 58, 59, 59 mm.; " ♀?" 56 mm.

Type.—Male; Guadalcanar; July 20, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 220107.

Named in honor of the collector, Mr. R. H. Beck. Three males and one female were sent.

Though some of these forms have no yellowish central line on the crown, they have been treated as subspecies of *Phylloscopus trivirgatus,* such as *giulianetti* from southeastern New Guinea, *everetti, matthiæ,* etc. The similarity between *everetti* and *becki* is surprising, as we find more different forms on New Guinea.

Juvenal.—Upperside even darker than in the male, underside as in the female, except the abdomen which is brownish ochre-yellow, more rufescent on the sides.

Male (fere, adult): wing, 91; tail, 70 mm. ♀: wings, 87, 89; tails, 69, 71 mm.

Type.—Male (fere), adult; Guadalcanar; July 25, 1927; R. H. Beck Coll.; Amer. Mus. Nat. Hist. No. 218045.

Pachycephala implicata, new species

Four specimens from Guadalcanar, July, 1927.

This bird, quite overlooked hitherto in spite of former collections made on Guadalcanar, is a very aberrant *Pachycephala.*

No. 27052 I take to be the nearly fully plumaged male; Nos. 27053 and 26855 must be adult females, though the latter is sexed "♂" and No. 27055 is juvenal.

ADULT MALE.—Crown and sides of head dark ashy gray with blackish shaft-stripes (possibly becoming more blackish with age?), rest of upperside olive-green with a yellow tinge; tail dark brown with olivaceous-green outer edges; quills dark brown with brownish olivaceous edges and brownish buff inner edges. Throat gray and white, the slaty gray feathers coming in, so that, apparently, the full plumage has the throat gray. Rest of underside brownish olive-yellow, sides dusky green. "Iris brown, bill black, feet gray. Testes small."

ADULT FEMALE.—Upperside as in the male, only a shade more brownish. Throat white with indistinct gray shades and a brownish gray shade toward the chest. Underside a shade lighter brownish yellow. Bill also black.

TYPE.—Male; Whitney Island[1]; December 9, 1927; Hamlin Coll.; Amer. Mus. Nat. Hist. No. 219999.

This peculiar new form is nearest to *Pachycephala pectoralis dahli* Reichenow, from the Bismarck Archipelago, where it inhabits chiefly small outlying islands, there representing, as a rule, *Pachycephala pectoralis finschi*, the male of which is very much like that of *P. p. dahli*, but has the edges to the primaries more greenish, and has different dimensions and a different female. In *P. p. dahli*, however, the throat is invariably pure white, abdomen always bright yellow, bill slightly smaller. The female differs from that of *P. p. dahli* in having the back darker, more olivaceous, the head less in contrast to the back, the abdomen less bright yellow, with darker flanks. It is, however, a very close ally of *P. p. dahli*.

I have unhesitatingly treated *P. p. dahli*, *finschi*, and many others, as subspecies of the widespread *pectoralis*, while it would be hazardous to do this with *orioloides*, *melanonota*, and *christophori*. These latter three are for the present best treated as species. *P. melanonota* differs from the large *orioloides* in smaller size and absence of yellow collar on upperside, which is uniform black.

Pachycephala pectoralis whitneyi, new subspecies

ADULT MALE.—Crown, sides of head and broad pectoral collar black; behind the black crown a yellow ring; back and rump and edges to secondaries olive-green, upper tail-coverts black in the middle of the feathers. Quills black, inner webs bordered with grayish white, outer ones with olivaceous-gray. Rectrices black, narrowly tipped with grayish-brown. Throat in specimen No. 29814 snow-white, in No. 29813 white, washed with lemon yellow, in No. 29865 lemon yellow, only chin whitish. Breast and abdomen in the first orange, in the second lemon yellow, in the third yellow with an orange wash. "Iris brown, bill black, feet gray or blackish gray."

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[1] Named in honor of Mr. Harry Payne Whitney, to whose generosity the Whitney Expedition was due.

ADULT FEMALE.—Upperside greenish olive, crown with a gray tinge. Throat dull white, the feathers with ashy-gray tips and subterminal spots; a vinaceous-gray (almost Ridgway's "ecru-drab") chest-band with gray stripes; abdomen and under tail-coverts pale lemon yellow with faint grayish shaft-stripes, flanks washed with grayish brown. "Iris brown, bill black, feet gray."

Wings: ♂, 89, 92.5 , 95; ♀, 89, 90, 90 mm. Tail· ♂, 67, 67.5, 68; ♀, 66.5, 67.5, 68 mm. Bill, from forehead: ♂, 40, 41; ♀, 39, 39, 40 mm.

Pachycephala christophori Tristram

Pachycephalus christophori TRISTRAM, 1879, Ibis, p. 441 (San Cristobal).

3 ♂, 3 ♀; Baurc or San Cristobal; March 29, April 4, 5, 6, and 14, 1927.

Neither of the males, though otherwise adult in plumage and having large testes, has a perfectly black crown, like some of those in the Tring Museum. No male from San Cristobal has a complete yellow ring around the neck, the collar only being indicated by two yellow patches on the sides which do not connect. Two of the females must be adult and they must have had enlarged ovaries, the third still has rufous patches on the jugulum and rufous edges to the secondaries, and the ovary was small.

The males have a shade of rufous-brown below the black pectoral band, which is rather wide.

Pachycephala melanonota Hartert

Pachycephala melanonota HARTERT, 1908, Bull. B. O. Club, XXI, p. 106 (Vella Lavella, central group of Solomon Islands); 1918, Nov. Zool., p. 358.

2 ♂, ad.: Vella Lavella; November 15, 1927.

3 ♂, ad., 3 ♀, juv. (?): Ganonga Island; October 19–22, 1927; breeding.

The young birds are different from those I originally described as females which, however, must be young birds. They are much like the adult female, but they are all three marked as young males, and all three show signs of immaturity. I would willingly believe them to be young males, and our specimens young females, but one of our birds which has a bright yellow underside and chestnut-red head, olive back with black spots, shows the black pectoral band of the adult male. The specimens collected by R. H. Beck and F. P. Drowne have the under surface yellowish green with dusky spots, crown olivaceous with chestnut rufous, wings outside chestnut-red, and one has bright chestnut-red spots on the sides of the head and neck and on the chest. Could they be young females, and our former ones young males, though partially marked "♀"?

Pachycephala orioloides Jacquinot and Pucheran

?*Pachycephala astrolabi* BONAPARTE, 1851 (?), 'Consp. Gen. Av.,' I, p. 329 (before February, 1851—Nomen nudum! This name has always been adopted, but Mathews calls my attention to the fact that it cannot possibly be accepted, as it is by no means clear to which of the six figures of Hombron and Jacquinot the name refers).

Pachycephala orioloides JACQUINOT AND PUCHERAN, 1853, 'Voy. Pôle Sud,' Zool., III, p. 57 (ex Hombron and Jacquinot, 'Voy. Pôle Sud.,' Pl. v, fig. 3. Island of San Jorge, or St. George, near Ysabel).

3 ♂, ad., 4 juv.: Guadalcanar; April, May, July, 1927. ♂, ad., ♀, ad.: Florida; May, June. ♂, ad.: Banika; August 1, 1927. ♂, ♀, ad.: Choiseul; November, 1927. 1 ♂, 2 ♀: Ysabel; August, 1927. ♂, juv.: Vella Lavella; November 14, 1927. ♂, ♀: Russell or Pavuvu Islands; August 3, 1927. Also 2 ♂, ad., 1 ♀ from an island which I cannot locate, for I cannot read the name on the label.

Rothschild and I have described the various plumages in Nov. Zoöl., 1901, p. 375; 1905, p. 265.

Dicrurus (Dicruropsis) longirostris Ramsay

Dicrurus (*Chibia*) *longirostris* RAMSAY, 1883, Proc. Linn. Soc. N. S. Wales, VII, p. 300 (San Cristobal).

2 ♂, 2 ♀: Bauro (San Cristobal); March, 1927; Beck and Drowne Coll.

This long-billed form is very different from *D. meeki* Rothschild and Hartert, 1903, Nov. Zoöl., p. 110, of Guadalcanar. It has weaker bristles, a longer and more curved bill, lacks the "hackles" on the sides of the neck, and differs in other details. There are glossy tips to the feathers on the crown and on the chest, but not on the back. The iris is described as dark red by Meek and Eichhorn, while Drowne describes it as brown, which can hardly be quite correct. Wings: ♂, 146, 148; ♀, 142, 144 mm. Only known from San Cristobal and rare in collections.

Aplonis (Calornis) metallica nitida (Gray)

Calornis nitida GRAY, 1858, Proc. Zool. London, p. 181 (New Ireland).

2 ♂, 1 ♀: Bauro (San Cristobal); March, April, 1927; Beck and Drowne Coll. ♀: Ramos Island; September 5, 1927; David Coll. I cannot give the locality of two additional specimens as I am unable to decipher the label.

Aplonis cantoroides cantoroides (Gray)

Calornis cantoroides GRAY, 1861, Proc. Zoöl. Soc. London, p. 431 (Mysol).

This widespread form is rare on the Solomon Islands. Meek and Eichhorn sent skins from Gizo, Choiseul, and Bougainville, also two from Guadalcanar. An old and a young specimen were received from the latter island. They were collected by Mr. R. H. Beck in April and May.

Aplonis (Lamprocorax) grandis (Salvadori)

Lamprotornis fulvipennis (not of Swainson, 1837) HOMBRON AND JACQUINOT, 1853, 'Voy. Pôle Sud,' Zool., III, Ois., p. 81 (Ysabel Island).

Lamprocorax grandis SALVADORI, 1881, 'Orn. Pap. e Molucce,' II, p. 460 (new name for *fulvipennis*, because it was preoccupied and "not suitable").

Calornis maxima TRISTRAM, 1895, Ibis, p. 375 (Ysabel).

2 ♂, 1 ♀: Guadalcanar; April, 1927; Drowne and Hicks Coll.
♀: Ysabel; August 22, 1927.

Aplonis (Lamprocorax) dichroa Tristram

Sturnoides minor (not *Calornis minor* Bonaparte, 1851) RAMSAY, 1882, Proc. Linn. Soc. N. S. Wales, VI, p. 726 (San Cristobal).

Calornis dichroa TRISTRAM, 1895, Ibis, p. 376 (new name for *C. minor*, as it is preoccupied).

2 ♂, 2 ♀: Bauro (San Cristobal); March and April, 1927; Beck and Hicks Coll.

This form represents *A. grandis*, but considering the great difference in size, the brown instead of metallic black INNER remiges, and the more square tail, it is better kept as a species and not as a subspecies of *grandis*.

Mino dumonti kreffti Sclater

Mino kreffti SCLATER, 1869, Proc. Zool. Soc. London, Pl. IX, p. 120 ("Solomon Islands").

Unfortunately, the type locality is uncertain, no exact island being indicated, and Brown (the collector) did not carefully label his specimens, some being from New Britain or Duke of York Islands, though described from the Solomon Islands. Mr. Kinnear and I have carefully compared the type and have no doubt that it is a specimen of the common Solomon Islands form, but it is not from Guadalcanar. Its wing measures 160; bill from frontal feathers, 21; width of upper mandible over nostrils, 10.5; wing-bar on outer web of fifth primary, 21 mm. These measurements are not very large, but the wing-bar is too wide for the average New Britain specimens.

A specimen from Russel or Pavuvu Island in the Solomon group, No. 218472 of the Whitney Expedition, collected by R. H. Beck, has the abdominal patch not yellow, but orange, like *M. dumonti dumonti.* It is also very large; wing, 175 mm.

This might be a different subspecies, but the orange color of the abdomen might be aberrant, and the wing alone cannot serve as a differentiating character, as single specimens with a similarly long wing, 175 mm., are also extant in Tring from Florida and New Hanover, while males from Bougainville have sometimes a wing measurement of 170 mm.; from the Shortland Islands, 170 mm. While the male from Florida has a wing of 175 mm., the female wing is 163 mm. only. Thus females are usually smaller than males, and some specimens, in which this is not the case, may be wrongly sexed.

Skins from New Hanover, New Ireland, Bougainville, Ysabel, Shortland Islands, Vella Lavella, Kulambangra, and Choiseul usually have the following measurements. Wing: ♂, 167, 167, 162, 166, 166, 169, 157 (?), 167, 165, 165, 172, 160, 169, 168, 165.5, 172, 155 (? ♀), 165 mm.; ♀, 166, 158, 160, 156, 164, 163, 165, 160, 163, 162, 164, 157, 154, 152, 154, 154 mm. This would make males 160–170, 172, rarely 175 mm. —probably specimens with wings under 160 mm. are females. Females, 152–166 mm., but specimens with wings over 160 mm. may be males.

Unfortunately, not many specimens are available from Guadalcanar. There is only one pair in the Whitney Expedition collection; these were shot April, 1927. The supposed male has a wing of 149 mm. The female wing (worn) measures about 152 mm. We have five Guadalcanar examples in Tring. Three of them are labeled as males and have wings of 157 and 158 mm., while the females' wings are 147 and 150 mm. Moreover, the Guadalcanar birds have more slender, more gracile bills, the width of the bill over the nostrils being 9–10 mm., in the others, 10–12 mm.

Therefore, it seems evident to me that Guadalcanar harbors a smaller subspecies, which I propose to call *Mino dumontii sanfordi,* in honor of the energetic furtherer of ornithological collecting by the American Museum.

Mino dumontii sanfordi, new subspecies

TYPE.—"Male," Guadalcanar; April 28, 1901; A. S. Meek Coll.; No. 3028 in the Tring Museum.

I consider *kreffti* as a subspecies of *dumontii* and distinguish therefore:

Mino dumontii dumontii Lesson, 1830: New Guinea, Jobi, Waigiu, Salwatti, and Batanta. (*Mino dumonti violaceus* Berlepsch, 1911, is a synonym.)

Mino dumontii aruensis Stresemann, 1922: Aru Islands.

Mino dumontii kreffti Sclater, 1869: Solomon Islands, New Hanover, New Ireland. (*Gracula gnathoptila* Cabanis and Reichenow, 1876, is a synonym. It was not described as differing from real *kreffti*, but compared with specimens of *dumontii*, which were erroneously believed to be *kreffti*).

Mino dumontii gilian Stresemann, 1922: New Britain.

Mino dumontii sanfordi Hartert: Guadalcanar Island.

Corvus (Macrocorax) woodfordi woodfordi Grant

Macrocorax woodfordi Grant, 1887, Proc. Zool. Soc. London, p. 332 (Guadalcanar).

Topotypical *woodfordi* were obtained in May. Measurements of wings cannot well be given, as the wings are distorted, the shoulder joint being straightened out.

Corvus (Macrocorax) woodfordi vegetus Tristram

Macrocorax vegetus Tristram, 1894, Ibis, p. 30 (Bugotu = Ysabel Island).

A male from Ysabel Island; August 13, 1927.

Corvus (Macrocorax) woodfordi, subspecies

A female from Choiseul is somewhat smaller than females of *C. w. vegetus*. Wing, 275 mm. Our three specimens, collected by Meek and Eichhorn, have wings of 291 (♂), and 287 (♀) mm.; the third has a worn wing (see the measurements given in Nov. Zoöl., 1902, p. 584). Rothschild and Hartert have enumerated the Choiseul specimens as *vegetus*, while Meinertzhagen, Nov. Zoöl., XXXIII, 1926, p. 74, has called them *C. woodfordi woodfordi*. A larger series will probably show that they are intermediate between the two, but at present it would be rash to decide what they are. Where subspecies have developed, we do not find them alike on Guadalcanar and Choiseul, while the Ysabel form differs (cf. Nov. Zoöl., 1905, pp. 243, 244).

AMERICAN MUSEUM NOVITATES

Number 365 Published by The American Museum of Natural History New York City July 30, 1929

59.88 12 (935)

BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. IX[1]

ZOSTEROPIDÆ FROM THE SOLOMON ISLANDS

BY ROBERT CUSHMAN MURPHY

In the eighth paper of this series, Dr. Hartert has reported upon a collection of birds from the Solomon Islands. The following notes are based upon longer series, than those to which he had access, of some of the same Zosteropidæ, and upon additional specimens that have come to the American Museum since the former consignment was sent to Tring. All of the skins were obtained by Messrs. Beck, Hamlin, Richards, Dr. Drowne, and their associates of the Whitney South Sea Expedition, during 1927 and 1928. They comprise birds from twenty islands of the Solomons, including Rennell, which lies some distance off the southern end of the main chain.

Dr. Hartert has remarked in various papers that further revision of the large and complicated genus *Zosterops* will lead to a new grouping of certain names now used binomially, when the status of many forms as geographic representatives of others becomes established. In the following notes an attempt has been made to indicate the subspecific relationships of certain birds that have been, or might be, described as full species. *Zosterops* has penetrated in such an astonishing way into almost innumerable insular groups over a large part of the world, and has been enabled, because of the resulting isolation, to split up into so many strains with more or less striking differences, that a final monograph of the family must await far more thorough collecting and detailed systematic description. In the possession of certain characteristic plumage patterns, together with wide differences in the coloration of particular areas, and the tendency to enlarge, reduce, or completely suppress such a feature as the white eye-ring, these birds offer many puzzling genetic problems; and because of the large number of forms, and their geographic relationships through chains of contiguous islands, they offer unusual opportunity for the interpretation of such characters by analogy with results obtained through the breeding of birds under conditions of laboratory control. If it were possible to breed *Zosterops* as a laboratory animal in the same manner that pigeons, canaries, and other birds have been used, the possibility of understanding many intricacies in the evolution of birds might become extremely hopeful.

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[1] Previous papers in this series comprise Amer. Mus. Novitates, Nos. 115, 124, 149, 322, 337, 350, 356, and 364

In this connection, a few remarks about examples from the present report may be called for. The endemic *Zosterops* of Rendova Island, and that of its neighbor, Tetipari Island, are treated as subspecies, although, from a taxonomic point of view, the revealed differences in their plumage are clear and outstanding. *Z. rendovæ rendovæ* is a yellow-breasted bird, *Z. rendovæ tetiparia* a white-breasted bird; in other respects they appear practically identical. The question of interbreeding, into which we would examine if we were considering continental forms, does not enter, because each of these birds is perfectly isolated upon its own exclusive island. Neither do the two forms show a trace of intergradation. It is improbable, however, that any amount of interbreeding, even if it were made possible, would produce intergradation, for in similar crosses one such plumage is likely to prove completely dominant over the other.

These two forms are excellent examples of what Chapman and Stresemann call mutants, although "saltation" would be a better term for the result that has been expressed, because we have no evidence as to when the actual change in a gene occurred. The result may, indeed, be due to the recent uncovering of a condition carried for a wholly indeterminate length of time in the germ plasm. In any event, the birds I designate *Z. rendovæ rendovæ* and *Z. rendovæ tetiparia* may differ genetically by only a single factor pair. One of them would thus be the homozygote, preserved as such because it is imprisoned, so to speak, in the laboratory cage of an island. In view of the large and constantly accumulating experimental data on precisely parallel cases, there is no reason why we should obscure the facts of relationship by calling these birds two distinct species. Nomenclature, and not nature, must do the adapting.

Conclusions as to a definite breeding season cannot be drawn from notes on the condition of the gonads among our specimens of *Zosterops* from the Solomons. In every series, and at all dates, without exception, some birds had enlarged, and some small, sex organs. The presence of nestling young among them is noted in the text below. The numerical superiority of males over females in the collection is characteristic of many series of Passeres.

Since most of the Solomons are lofty islands, it is probable that differing zonal distribution not infrequently distinguishes the ranges of two resident species of *Zosterops* on any one island. Unfortunately, altitude is not recorded on the labels of the Whitney Expedition specimens, but information on the matter is by no means lacking in the comprehensive notes kept by Messrs. Hamlin and Richards and Dr. Drowne. In the majority of instances it is easy to identify with exactitude the birds to which their remarks refer, and when the time for fuller treatment arrives it will be possible to throw some light upon this subject.

Zosteropidæ

Zosterops alberti alberti Rothschild and Hartert

Zosterops alberti ROTHSCHILD AND HARTERT, 1908, Novit. Zool., XV, p. 364 (Bauro, or San Cristobal Island, Solomon Group).

Zosterops alberti alberti, HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 10.

Five males from Bauro, April 8, 1927, one of them a juvenal not long out of the nest. The plumage of the young bird differs from that of adults only in lacking a brownish tinge on the forehead. This is noteworthy because its absence is a permanent character of the next subspecies.

Iris, brown; bill, black, with a faint horny tinge at the base of the mandibular rami; feet and legs, "gray."

Zosterops alberti oblita Hartert

Zosterops alberti oblita HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 10. (Guadalcanar Island).

Fourteen males, three females, Guadalcanar, May 30, 31, July 18–22, 1927.

The chief characters of this race are the yellow, under tail-coverts and the absence of a brownish tint on the forehead, as noted by the describer. In addition to these, however, most specimens of *oblita* show an obsolescent but perfectly discernible ring of minute white feathers around the eye. Here, in short, is the familiar zosteropid eye-ring in last vestige. The condition is notable because of the manner in which the character becomes either accentuated or completely obliterated in closely related forms.

Zosterops alberti hamlini, new subspecies

SUBSPECIFIC CHARACTERS.—A narrow but conspicuous circumorbital ring of white feathers, with a hiatus at the anterior canthus of the lids; throat, greenish, like the dorsal plumage; a broad band of gray across the upper breast, blending with the greenish of the throat and ending where the soiled whitish of lower breast and belly begins. *Z. a. hamlini* shares the brownish forehead of the subspecies *alberti* and the yellow, under tail-coverts of *oblita*.

ADULTS (sexes alike).—Dorsal surface, olive-green, tinged with brown on forehead and anterior part of crown; quills fuscous, the remiges proximally warbler green on their outer vanes, the rectrices externally olive-green; greater coverts and bend of wing, fuscous; lining of wing, white; lores and circumorbital region, except for the white eye-ring, blackish; cheeks and sides of neck, olive-green, and throat distinctly washed with the same color; a few whitish feathers on the chin and interramal region; breast and flanks, neutral gray, blending somewhat irregularly with the white of the belly, which is also slightly tinged with neutral gray; thighs, proximally gray and whitish, distally tinged with olive greenish; under tail-coverts, pinard yellow. Iris, brown; bill black, except for the base of the mandible, which is horn color; feet and legs, "gray."

TYPE.—No. 222,098, Amer. Mus. Nat. Hist.; ♂ ad.; Bougainville Island, Solomon Group; January 27, 1928; F. P. Drowne.

MEASUREMENTS.—(4 males, 2 females): wing, 66–69; tail, 44–49; exposed culmen, 13.5–14.5; tarsus, 20.5–22 mm.

RANGE.—Bougainville Island.

Fourteen males, seven females, Bougainville, December 31, 1927, January 2–25, 1928.

This distinctive new bird is so obviously related to the races *alberti* and *oblita* that I regard it as a subspecies, and look for the discovery of similar insular representatives somewhere in the long chain of scattered land masses lying between Bougainville, at the northwestern end of the Solomon Archipelago, and Bauro and Guadalcanar, at the southeastern end. In fact, the *Zosterops salomonensis* of Finsch (1901, 'Tierreich,' Lieferung 15, p. 42), a bird of unknown source, is probably such a representative. Finsch's description of *salomonensis* matches that of *hamlini* except that the former is said to have white under tail-coverts and to lack the circumorbital ring and the greenish throat.

The Bougainville bird agrees in size with the subspecies *alberti* and *oblita* except for the tail, which is longer in *hamlini*. It combines certain color characteristics of each of the other races (viz., color of forehead and under tail-coverts), and has added the greenish throat and the intensified grayness of the breast.

In this, and other forms of *Zosterops*, the sexes seem to be alike in size as well as in plumage, and the pattern and hue of juvenals resemble those of the adult state.

Zosterops metcalfii metcalfii Tristram

Zosterops metcalfii TRISTRAM, 1894, Ibis, p. 29, Pl. III, fig. 1 (Ysabel, or Bugotu Island).

Zosterops metcalfei metcalfei, HARTERT, 1929, Amer. Mus. Novit., No.364 , p. 11.

Ten males, five females, Ysabel, August 13–25, September 8, 1927; eight males, eight females, Tulagi, May 23, June 23, July 9–12, 1927.

Bill, black, except for the base of the mandible, which is yellow on the rami from a point just anterior to the gonys.

Ysabel and Tulagi (St. George) are practically one island, being separated only by a very narrow strait which resembles a drowned valley.

Hartert has grouped with the topotypical birds the specimens from Bougainville, Choiseul, and Shortland Islands, but our large series from the latter localities show a slight but constant difference which may be recognized subspecifically.

Zosterops metcalfii exigua, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Zosterops metcalfii metcalfii*, but differing in that the entire lower mandible is horny yellow in color, instead of largely black.

TYPE.—No. 220,057, Amer. Mus. Nat. Hist.; ♂ ad.; Shortland Island, Solomon Group; December 13, 1927; R. H. Beck.

MEASUREMENTS.—(6 males, 2 females, from the four islands listed below): wing, 57–66; tail, 36–40; exposed culmen, 13–14.2; tarsus, 16.5–17 mm.

RANGE.—Shortland, Choiseul, Bougainville, and Buka Islands, at the northwesterly end of the Solomon chain.

Sixteen males, nine females, Shortland, December 13–16; six males, five females, Choiseul, November 18–25; December 16, 1927; eighteen males, nine females, Bougainville, December 6 and 31, 1927, January 12–20, 1928; two males, three females, Buka, April 10–12, 1928.

The distinction in bill coloration constitutes a very slight character, but it appears to be invariable throughout large series. It is not only apparent in dried skins, but proves to be a difference noted on the labels by the collectors.

No size difference between the subspecies *metcalfii* and *exigua* is appreciable, All races of *metcalfii* are smaller than those of *alberti*, the proportional difference being least in bill length and greatest in that of the tarsus.

Several fledglings in the series are distinguishable from adults only by their softer and looser plumage.

Zosterops metcalfii floridana Rothschild and Hartert

Zosterops floridana ROTHSCHILD AND HARTERT, 1901, Novit. Zool., VIII, p. 180 (Florida Island).

Zosterops metcalfei floridana, HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 11.

Five males, five females, Florida Island, May 24–26, 1927.

In this race, the disappearance of the circumorbital white feathers again figures as a racial character. Color differences are scarcely appreciable, and dimensions agree with those of the other subspecies.

Zosterops rendovæ Tristram

Zosterops rendovæ TRISTRAM, 1882, Ibis, p. 135 (Rendova Island, Solomon Group); figured, 1894, Ibis, Pl. III, fig. 2.

Tephras olivacea RAMSAY, 1881, Proc. Linn. Soc. N. S. W., VI, p. 180 (specific name preoccupied).

SPECIFIC CHARACTERS.—Entirely black-billed Zosteropidæ, with or without white circumorbital feathers in the respective races; with yellowish green dorsal surface, olive-yellow breast, brownish black quills, yellow under tail-coverts, and the belly either yellow or white, according to geographic race.

The Whitney Expedition material seems to warrant at least a provisional allocation of the several closely related forms of *Zosterops* inhabiting a closely linked complex of islands in the central part of the Solomon Archipelago, namely, Rendova, Tetipari, Kulambangra, New Georgia, Vangunu, and Gatukai. In this case, as in so many other systematic studies, we find an interesting correlation between relative geographic isolation and the degree of difference shown by the resident birds. Thus Rendova and Tetipari, which are high islands, separated from the low southwestern coast of New Georgia by the considerable expanse of Blanche Channel, each have very distinct endemic forms. On the other hand, the chain of islands from Kulambangra to Gatukai, all close together and with intimately connecting islets and reefs, comprises the range of a single subspecies. In my opinion, all three of the forms mentioned should be grouped as one species, their differences having a familiar genetic aspect, and all of them involving characters known to be highly variable in this family of birds.

Results of the field work show that no taxonomic finality can be reached until collecting has been carried much further. The Solomons are full of surprises, even on the supposedly well investigated islands. Any neighboring islet, however small or apparently insignificant, is likely to harbor a new *Zosterops* of this or some other species, and the same is true of the little known faunistic zones in the high altitudes of the larger islands.

The bird of Rendova, described by Tristram in 1882, becomes the type form of the species under consideration.

Zosterops rendovæ rendovæ Tristram

SUBSPECIFIC CHARACTERS.—No white eye-ring; lores, very sparsely feathered, and appearing black from the color of the skin; entire dorsal surface bright yellow-green (richer than the yellowish citrine of Ridgway, and close to warbler green); sides of head and neck, and the breast and flanks, of nearly the same color, but a little lighter, verging toward pyrite yellow; chin and throat tinged with light orange-yellow; belly, thighs, and under tail-coverts, empire yellow; quills of wing and tail, fuscous-black, the remiges pyrite yellow on the proximal parts of their outer webs; greater coverts, olive-yellow; bend of wing, pinard yellow; lining of wing, white, tinged with yellowish. Bill, black; iris, not recorded; legs and feet, not recorded but pale, apparently light yellow or flesh-color.

MEASUREMENTS.—(4 males, 2 females): wing, 63–68; tail, 40–47; exposed culmen, 14–15; tarsus, 18–19 mm.

RANGE.—Rendova Island.

Twenty-two males, seven females, Rendova, May 19–23, August 9, 10, 1928.

Tristram's plate does not indicate the extremely yellow belly of this bird, which is much brighter and clearer than in the form of New Georgia and its neighbors.

The distance between Rendova and the mountainous land of New Georgia appears to be about twenty miles, although the minimum distance between the shores of the two islands is not more than five miles at the western end of Blanche Channel.

Zosterops rendovæ tetiparia, new subspecies

SUBSPECIFIC CHARACTERS.—Differs from *Zosterops rendovæ rendovæ* in that the belly is white from breast to crissum, sometimes very faintly tinged with yellowish, while the flanks are gray (deep gull gray of Ridgway); the throat and breast are, moreover, slightly lighter than in subspecies *rendovæ*, the region being tinged more extensively with light orange yellow. This race also practically lacks the circumorbital ring, but in many cases a partial row of minute white feathers can be discerned.

TYPE.—No. 222,074, Amer. Mus. Nat. Hist.; ♂ ad.; Tetipari Island, Solomon Group; August 7, 1928; Hannibal Hamlin.

MEASUREMENTS.—(4 males, 2 females): wing, 60–65; tail, 41–44; exposed culmen, 14–14.8; tarsus, 18–19 mm.

RANGE.—Tetipari, or Montgomery, Island.

Eleven males, five females, Tetipari, August 6–8, 1928.

This is obviously a representative form of the Rendova bird that lacks the lipochrome activator for a restricted part of its pattern and is, in consequence, white-bellied. The retention of dark pigment in the flanks, with resulting gray instead of green, is just what would be expected under the circumstances. It shares with the other form the blackish, thinly feathered lores.

Tetipari is a small island, lying to eastward of Rendova, from which it is separated by a strait less than two miles in width. It is fifteen miles, or thereabouts, from the nearest points of New Georgia and Vangunu.

Zosterops rendovæ kulambangræ Rothschild and Hartert

Zosterops kulambangræ ROTHSCHILD AND HARTERT, 1901, Novit. Zool., VIII, p. 180 (Kulambangra Island); HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 11.

SUBSPECIFIC CHARACTERS.—A small but perfectly definite circumorbital ring of white feathers; blackish feathering of the lores carried forward to the nostrils and in a narrow line across the junction of forehead and bill; belly and flanks more generally tinted with amber yellow, without the brilliance and concentration found in typical *rendovæ*, and without the distinct line of demarcation between breast and belly shown by the subspecies *rendovæ* and *tetiparia;* also averaging slightly smaller, particularly in length of tail, than either of the two preceding races.

MEASUREMENTS.—(6 males, 2 females, from the four islands listed below): wing, 60–65; tail, 38.5–40; exposed culmen, 14–15; tarsus, 18.5–19 mm.

Sixteen males, five females, Kulambangra, September 23–28, October 5–13, 1927; twenty-four males, twelve females, New Georgia, June 4–19, 1928; eleven males, six females, Vangunu, July 18–25, 1928; seventeen males, six females, Gatukai, June 25–29, 1928.

Birds from these four contiguous islands are indistinguishable from one another. Juvenals, and a nestling taken at Gatukai on June 25, show all the characters of adults, being only paler on throat and belly and greener on breast and flanks. Young birds, moreover, have strikingly compressed bills in this and the other races.

Future collecting at the islands of Arundel, Wanawana, Mbulo and elsewhere, is likely to extend the known range of this subspecies.

Zosterops murphyi Hartert

Zosterops murphyi HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 11 (Kulambangra Island).

ADULTS (sexes alike).—Bill, particolored, being black on maxilla and the distal half of the mandible, and yellow on the mandibular rami and the base of the gonys; dorsal surface, olive-green, including the external fringing of the fuscous-black quills; a broad and continuous circumorbital ring of white, silky feathers: ventral surface, laterally warbler green, with a median tinge of pyrite yellow, heightening to amber yellow on the chin, and to olive-yellow on the belly and under tail-coverts. Iris, brown; feet and legs, "gray."

MEASUREMENTS.—(3 males, 3 females): wing, 63–65; tail, 41–45; exposed culmen; 13.8–14.8; tarsus, 18.5–20 mm.

Fourteen males, six females, Kulambangra, October 2–13, 1927.

Zosterops vellalavella Hartert

Zosterops vellalavella HARTERT, 1908, Bull. Brit. Orn. Club, XXI, p. 106 (Vella Lavella Island); 1929, Amer. Mus. Novit., No. 364, p. 12.

Twenty-one males, nine females, Vella Lavella (Veka Vekalla), November 8–16; thirteen males, three females, Bagga Island, November 5–7, 1927.

This species has an entirely bright yellow bill, and yellow legs and feet. The color of the dorsal surface is brilliant yellow-green, as in *Z. rendovæ*, not olive-green. The throat is close to light orange-yellow. A nestling taken at Vella Lavella on November 8 is coming into plumage of the adult type. Its bill was horny brownish and its legs gray.

Bagga lies just west of the type locality, and very close to it.

Zosterops luteirostris Hartert

Zosterops luteirostris HARTERT, 1904, Bull. Brit. Orn. Club, XIV, p. 61 (Gizo Island); 1929, Amer. Mus. Novit., No. 364, p. 12.

Fourteen males, four females, Gizo, October 5–November 2, 1927, May 28–30, 1928.

This is another yellow-billed form, which may be closely related to the bird of Vella Lavella and Bagga, although in its brilliant ventral coloration it resembles the Ganonga Island species, next described. While strikingly different in general appearance from *Z. vellalavella*, the distinctions are quantitative rather than qualitative, and are similar to the evolutionary changes noted among other representative forms of *Zosterops* inhabiting the Solomons. In effect, *luteirostris* differs from *vellalavella* by the heightening and extension of black in the forehead and circumorbital region, a similar intensification of pigment in the quills, and the addition, or perhaps, rather, the retention, of a yellow instead of a white belly. The last difference is comparable with the distinguishing feature of *Z. rendovæ rendovæ* and *Z. rendovæ tetiparia* (*vide supra*).

In other words, *luteirostris* and *vellalavella* have a fundamentally similar facies, and their differences may be due only to the relatively slight genetic factors that determine the pattern and intensity of pigmentation.

Zosterops splendida Hartert

Zosterops splendida HARTERT, 1929, Amer. Mus. Novit., No. 364, p. 12. (Ganonga Island).

MEASUREMENTS.—(5 males, 1 female): wing, 60–61.5; tail, 39–41; exposed culmen, 13.8–14.6; tarsus, 17.5–18.5 mm.

Thirteen males, one female, Ganonga, October 19–25, 1927.

This very beautiful and intensely colored species was one of the important finds of the Whitney Expedition. It has a blacker and more extensive mask than *luteirostris*, and an entirely black bill combined, however, with yellow legs. Its throat and breast are slightly more golden than the light cadmium of Ridgway's 'Color Standards.' The corresponding parts in *luteirostris* are usually lemon chrome, although a few specimens approach *splendida* so closely in both the hue of the ventral surface and the character of the dark mask that bill coloration is left as the only important distinction in the appearance of the skins. Possibly *vellalavella, luteirostris*, and *splendida*, despite their marked differences, should eventually be recognized as a single Formenkreis inhabiting a closely associated cluster of islands. Ganonga is almost equally near to Bagga, Vella Lavella, and Gizo.

Dr. Hartert records the iris in this species as "brown or orange," but the collectors' notation on the labels of the whole series is uniformly "brown."

Zosterops rennelliana, new species

SPECIFIC CHARACTERS.—A small, greenish, plain-colored *Zosterops*, apparently resembling *Z. griseotincta*, of the Louisiade Archipelago, but without a white circumorbital ring; bill, entirely yellow; feet and legs, yellow; tarsus exceptionally heavy.

ADULTS (sexes alike).—Dorsal surface, including sides of head and breast, the flanks, and all but the greater wing-coverts, warbler green, with a faint ochraceous tinge on the feathers close to the nostrils, above the lores, and sometimes on the upper tail-coverts; quills of wing and tail. and greater wing-coverts, fuscous, their outer webs tinged with yellowish oil-green, and distally on the primaries with a russet hue; ventral surface, mainly yellowish citrine, brightening to strontian yellow on the throat, and to olive-yellow on the under tail-coverts and the center of breast and belly; feathering of thighs distally buff-yellow; bend of wing, yellow, the lining whitish, faintly tinged with yellow. The entire bird is more or less flecked with gray, owing to exposure of the basal parts of the feathers through the soft plumage. Iris, brown; bill, yellow; legs and feet, yellow.

TYPE.—No. 222,138, Amer. Mus. Nat. Hist., ♂ ad.; Rennell Island, Solomon Group; August 28, 1928; Hannibal Hamlin.

MEASUREMENTS.—(6 males, 2 females): wing, 61–67, tail, 38–44; exposed culmen, 13.6–14.8; tarsus, 19.4–20.6 mm.

RANGE.—Rennell Island.

Six males, two females, Rennell, August 25–30, 1928.

This new bird may well prove to be a race of some more widely distributed species of *Zosterops*. We have not at present sufficient comparative material to determine the point.

Rennell is a little known and isolated island, ninety or more miles southwest of Bauro, and the southernmost member of the Solomon Archipelago.

Woodfordia superciliosa North

Woodfordia superciliosa NORTH, 1906, Victorian Nat., XXIII, p. 104, Pl. VIII (Rennell Island).

MEASUREMENTS.—(5 males, 3 females): wing, 75–81; tail, 44–49; exposed culmen, 19–20; tarsus, 23.5–25 mm.

Specimens from Rennell, August 27–31, 1928.

North gave an excellent description of this interesting bird, known hitherto only from the type specimen. Unfortunately, the Whitney Expedition collectors neglected to record flesh colors upon the label of any example, but the bill in life was apparently horny brown, lighter on the mandible.

The reduced, outermost primary has a length up to nine or ten millimeters. The tail is squarish, as surmised by the describer. The bill and feet are characteristic of the Zosteropidæ, except that the operculum of the nostril is slightly less developed than is usual in the family, and the anterior half of the maxillary tomium has a finely serrate appearance, as in the Nectariniidæ. The notched tip of the maxilla is as in many species of *Zosterops*.

The bifid and brush-like tongue of this bird, as described by North, was supposed to indicate affinities with the Meliphagidæ. It is by no means certain, however, that some of the Zosteropidæ do not share this character, and *Woodfordia* agrees substantially with other members of the family. Except for the bare orbital ring and lores, and a shorter bill, it seems rather close to *Sanfordia lacertosa*, of Santa Cruz Island. The loss of the circumorbital ring is, of course, common among many species.

It is probable that alcoholic specimens of *Woodfordia* are included among recent Whitney Expedition collections, and a further report on the relationship of the bird may be made later.

AMERICAN MUSEUM NOVITATES

Number 366 | Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City | July 31, 192

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A NEW DIASPINE COCCID FROM SOUTH AFRICA

BY FREDERICK LAING AND T. D. A. COCKERELL

Chionaspis asparagi, new species

Puparium of adult female typically chionaspiform, narrow, snowy-white; exuviae pale brown marginally, darker centrally, both tipped with orange and with distinct median longitudinal ridges. Length 2 to 2.5 mm.

Puparium of male obtusely tricarinate, snow-white, pellicle very pale yellow.

Adult female clearing completely in caustic potash, longish oval to linear, the length approximately two and one-half times the breadth, cuticle finely striated

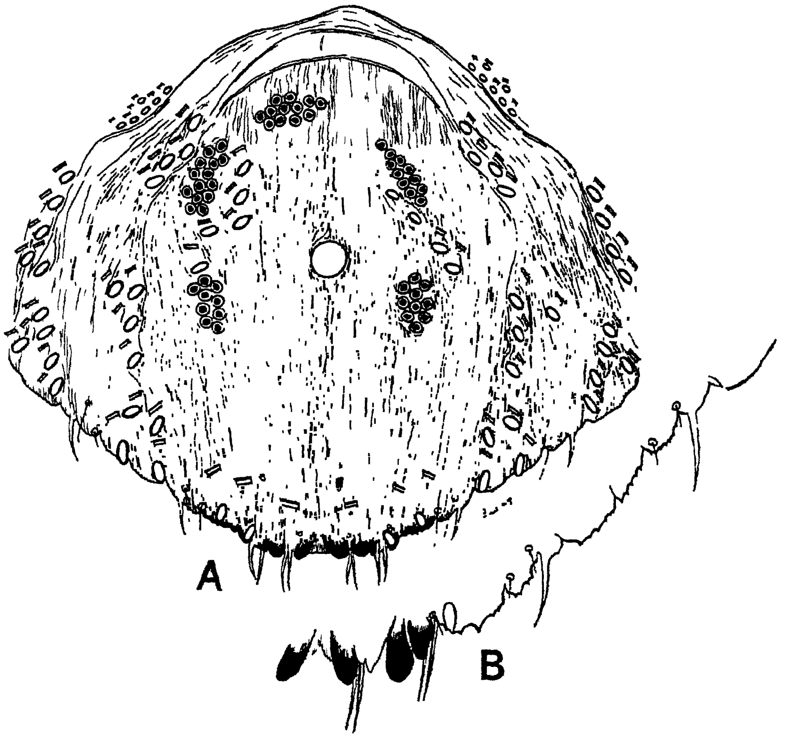

Fig. 1. *Chionaspis asparagi*, new species. A, pygidium; B, pygidial fringe of adult female.

transversely; antennal tubercles well developed, with a single stout, curved seta; cephalic area with a few minute setæ; both pairs of spiracles with a small group (1–3) of parastigmatic pores, the anterior pair with the larger number; the last two free abdominal segments only with pores and gland-spines on the marginal area. Pygidium with an exceedingly pliable fringe rendering a definite outline difficult to obtain in preparations; none of the trullæ projecting distinctly from the margin nor strongly developed; L_1 almost contiguous at base, diverging strongly apically, so that the inner margin of each forms a well-defined curve from base to apex; L_2 duplex, the inner lobule short and broad, the outer small and poorly developed; margin beyond with several gland-bearing prominences, and crenulate-serrate; spiniform squamulæ very long; the marginal series of tubipores conspicuous; dorsal pores consisting of 3–5 anteriors in first series, often asymmetrical, 4 posteriors and 4–5 anteriors in second series; perivulvar pores in five well-defined groups, the formula 9; 14; 8; 14; 10. Length, 1.3 mm.

Natal, South Africa, on wild asparagus (Prof. R. B. Cowles). Type specimen in The American Museum of Natural History.

Professor Cowles writes that the scale was found only on scattered plants, but where found was abundant.

The species belongs to the *stanotophri*[1]-*berlesii* group of the genus, and resembles most closely *C. berlesii* Leonardi, but may at once be distinguished by the much longer squamulæ, and apart from the weakness of the pygidial fringe, very noticeable when making a preparation, other characters which may serve to separate the two are the distance separating the median trullæ, the outer lobule of L_2 and the quite different arrangement of the dorsal pores in series 3. *C. stanotophri* has an additional pair of lobes, and the margin is different. *C. berlesii* was found on asparagus in Portici, Italy.

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[1] Cooley, when describing *Chionaspis stanotophri* used this spelling and called the plant *Stanotophrum glabrum*. The name of the plant genus is, however, *Stenotaphrum*, and theoretically the coccid should be known as *C. stenotaphri* Cooley.

AMERICAN MUSEUM NOVITATES

Number 367

Published by
The American Museum of Natural History
New York City

August 9, 1929

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A NEW BOWER-BIRD OF THE GENUS *XANTHOMELUS*

By James P. Chapin

Among the birds recently collected in New Guinea by Mr. R. H. Beck for The American Museum of Natural History there are three examples of a *Xanthomelus* which, though evidently a close ally of *X. aureus* and *X. ardens*, differs from them conspicuously in color, especially that of the underparts, and the shortness of the crown-feathers. It is undoubtedly a distinct species, of which I could find no published description; so to make sure that it has not been named, I have sent a pencil-sketch with measurements to Dr. Ernst Hartert. He replies that it is surely new.

I am happy, therefore, to be able to name it in honor of Mr. George F. Baker, Jr.

Xanthomelus bakeri, new species

Specific Cha[illegible]rs.—Related to *X. aureus*, but with short crown-feathering of scarlet color, wholly black underparts, and black upper wing-coverts—in the adult male plumage. The yellow area on the wing-quills is reduced to approximately the same size as in *Sericulus chrysocephalus*, but it extends to the outer webs of the bases of most of the primaries. On the other hand, the long cape of hair-like feathers overlying the upper back is very well developed, the tail is square, and the bill is stout, as in *Xanthomelus aureus*.

Type.—Male adult; Madang,[1] Territory of New Guinea; Aug. 29, 1928; A.M.N.H. No. 268253.

Adult Male (type).—Whole underparts black, with a faint bluish sheen on throat and chest, but becoming duller and more brownish black on abdomen. Under tail-coverts dull black, narrowly margined with olive-yellowish. From the throat the black area extends up over cheeks and ear-coverts to enclose the eye, so that there is a complete narrow band of black above the eye, connecting with the black loral area, from which a narrow black border extends up behind the nostril to the base of the culmen.

Remainder of forehead and crown deep scarlet-red with pronounced silky sheen, and varied over the whole middle of the crown with black. The crown-feathers are only about 8 mm. long, mostly black, with only scaly tips of scarlet-red. Nape cadmium orange, washed with scarlet, especially behind the temporal region, this coloration continuing to the long decomposed feathers of the "cape" which arise from the hind-neck and conceal the plumage of the whole upper back. The longest feathers of this cape reach a length of 56 mm. The lateral margins of the cape are most strongly tinged with flame scarlet or grenadine red.

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[1] Madang is the name now in use for Friederich Wilhelm Hafen, on the northwest side of Astrolabe Bay, in the former German Colony.

Scapulars, back, rump, and upper tail-coverts deep black, with very faint gloss. Tail square; the rectrices black, slightly brownish as seen from below. Wing rounded, the 10th (outermost) primary 60 mm. long, and 7th primary (4th from outer side) longest, nearly equalled by 6th. Alula and all upper wing-coverts, including primary-coverts, uniform black. Primaries black with light cadmium-yellow bases, the yellow area extending to the outer web on all but the outermost (10th) primary. The outer web of the innermost primary is yellow for a distance of 65 mm. from its base. The outermost secondary is yellow for about two-thirds of its length, with the distal third black. The black tips of the secondaries become gradually restricted on the proximal secondaries until the cadmium yellow on the outer web extends to within 12 mm. of the tip. Then the yellow becomes limited to the outer web, and the innermost secondaries are again entirely black. The under wing-coverts are black, except that the greater primary-coverts are yellow (outer ones tipped with blackish) and the longest under secondary-coverts are yellow, the next row black in middle, but broadly margined with light yellow.

Wing, 137 mm.; tail, 82; exposed culmen, 22; culmen to base, 25; depth of bill at nostril, 10 mm.; tarsus, 43 mm.

The colors of the eye and naked parts are not noted on the label; but the bill in the dried skin is blackish, shading at its base to light brownish; the feet are blackish with pads beneath toes light gray-brown.

IMMATURE MALE (from Madang, Sept. 3, 1928).—General color above raw umber, slightly lighter on crown and hind-neck, but much paler on anterior part of forehead, lores, and region about eye. The "cape" is faintly indicated by narrowing and very slight lengthening of feathers on hind-neck. Greater and middle upper wing-coverts have lighter, grayer margins, and the outer webs of remiges are tinged with orange-citrine. Inner webs of most of the remiges are light cadmium yellow, but this yellow color is limited to the basal part of the outer primaries, and there is no sharply limited yellow area as in adult male. Under wing-coverts dull yellowish, some of them with a little dusky mottling.

Tail-feathers olive-brown like back, but distinctly washed with greenish below, and shafts dull yellowish beneath.

Cheeks and ear-coverts dull buff, the feathers with faint dusky margins, and the color deepening to rufous buff on the longer ear-coverts. Chin and throat whitish buff, feathers of fore-neck with faint dusky tips. Breast and flanks pale cream-buff with irregular bars or lunulate marks of blackish brown; abdomen clear yellowish cream-color, and under tail-coverts similar but with a few narrow, wavy bars of dusky brown.

Wing, 134 mm.; tail, 78; exposed culmen, 21; tarsus, 43.

The third specimen is a male from Madang, Sept. 10, 1928, which has not quite reached maturity. It has scattered brownish feathers on its upperparts, a good deal of olive-buff, mottled with blackish, on the middle of the underparts, some blackish retrices, and some brownish. The yellow patch on the wing is not so clearly defined as in the adult. Otherwise it resembles the fully adult male, and has the wing 141 mm.; tail, 85; exposed culmen, 21.5; tarsus, 43.

SPECIMENS EXAMINED.—Besides the three individuals described above, the only specimens of *Xanthomelus* in the American Museum are two males of *X. aureus*. For comparison with *X. ardens* I have consulted the colored plate in Ogilvie-Grant's 'Report on the Birds Collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea,' Ibis, Jubilee Supplement No. 2, 1915, Pl. I.

In color-pattern this species emphasizes the relationship between the genera *Xanthomelus* and *Sericulus;* but in the form of its bill and the lengthening of its "cape-feathers" it clearly belongs with the former.

AMERICAN MUSEUM NOVITATES

Number 368 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Sept. 5, 1929

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A REVISION OF THE GENUS *PHŒBIS* (LEPIDOPTERA)

BY F. MARTIN BROWN

INTRODUCTION

The great variations and overlapping of forms in both sexes of the numerous species usually referred to as *Callidryas*, or *Catopsilia*, have made the group rather puzzling to taxonomists. A. G. Butler, in 1878, published the first really comprehensive review in his 'Lepidoptera Exotica,' later published as a 'Monograph of the Genus *Callidryas*.' Godman and Salvin in their part of the 'Biologica Centrali-Americana' have followed this revision fairly closely. Roeber in Seitz's 'Macrolepidoptera of the World,' volume V, has disregarded the previous works and reverted to the use of a single genus for the group. In addition, he has confused the relationship of several superficially similar species. Forbes, in a very brief key, recently published, has grouped the species into subgenera but follows the pre-Butler concept of a single genus.

With the exception of Roeber, each of the aforementioned authors has subdivided the species into groups fairly uniform within themselves, but each has considered the values of those groups differently. According to Butler's scheme there are four genera covering five groups. Godman and Salvin have split off a sixth group and erected a genus on it. Forbes recognizes two more groups, eight in all, but considers them all subgroups of a single genus. I agree with Forbes' grouping, but do not consider the Old World species and the *menippe* group as even closely allied to the general group under discussion. A study of the structure and immature stages of the Old World group (*Catopsilia*) shows it to be related to the eurymoid rhodocerids, and *menippe* to be the New World representative of the *Catopsilia* group of genera.

If, instead of regarding any one group of characters as predominant in generic value, we consider the various groups in their interrelationships, we find the species fall rather well into three of Butler's groups. These resolve themselves into three genera. One, *Catopsilia,* with the Asiatic *crocale* as its type, encompassed the entire Old World group and none of the New World forms. Since *Catopsilia* must be reserved for the

Old World group, which is only distantly related to the New World group, we must seek the proper generic name for the American species. *Callidryas* Boisduval has been used by many authors and would be suitable, but *Phœbis,* used in 1816 by Huebner, antedates it by probably thirteen years, and therefore must be used. In 1873 Butler designed *argante* as the type species. The generic names that have been suggested from time to time are listed below with the date of their publication, authors, and type species.

1816	*Phœbis*	Huebner	*argante*
1829	*Callidryas*	Boisduval	*eubule*
1873	*Metura*	Butler (nec Walker)	*cipris*
1873	*Aphrissa*	Butler	*statira*
1889	*Rhabdodryas*	Godman and Salvin	*trite*
1896	*Parura*	Kirby (for *Metura*)	*cipris*
1920	*Prestonia*	Schaus	*clarki*

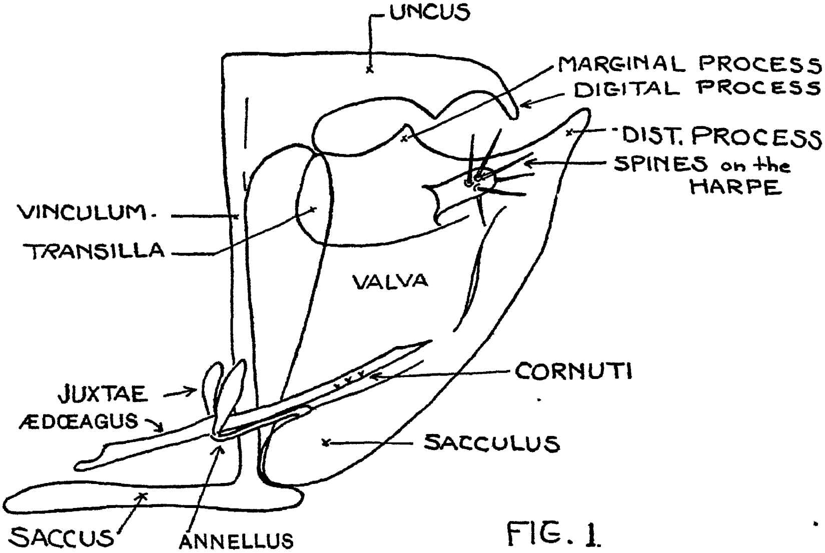

FIG. 1.

1. Labelled diagram of a hypothetical male armature.

Phœbis and *Aphrissa*[1] suffice for the New World forms. In studying the groups I have found that the structure of the genital armatures, especially in the males, is very useful not only in respect to specific value, but generic as well. Even a cursory glance at the slides of the male armature of the type species of the groups, *Catopsilia crocale*, *Phœbis argante* and *Aphrissa statira*, shows the generic value of a genitalic study in these groups.

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[1] Only the genus *Phœbis* is covered here; *Aphrissa* will appear in a future paper.

I have had the opportunity of making and studying a series of slides, several hundred in number, that includes every American species and race. From these I have chosen the most representative in each case to be used for the figures accompanying the text. The terms applied are, so far as possible, those used by Dr. Carl Heinrich in his various studies of genitalia. However, to allay any misunderstanding and to illustrate my interpretation of the terms, I have made a labelled diagram of a typical male genital armature.

KEYS

This group of insects presents a difficult task in the erection of a key for the separation of the two genera recognized, except in the case of the male armature; all other characters are extremely uniform or extremely variable and an encompassing key for them would be unwieldy.

KEY TO MALES, BASED ON GENITALIA

1. Harpes clothed with heavy, loosely attached spines; juxtæ filamentous (*Phœbis*)........2.
Harpes otherwise; juxtæ leaf-like (*Aphrissa*)........11.
2. Cephalad margin of transilla armed with a heavily spined pad (*labides*?)....3.
Cephalad margin of transilla unarmed........4.
3. Marginal process absent........*trite.*
Marginal process pronounced........*agarithe.*
4. Uncus blade-like; digital process very small, if present........5.
Uncus slender, with pronounced digital process........6.
5. Distal process long and slender........*philea, thalestris.*
Distal process absent or obscure........*avellaneda.*
6. Spines on harpes notched........*eubule.*
Spines on harpes not notched........7.
7. Ædœagus with very obscure cornuti; harpes sparsely armed with long, heavy spines........8.
Ædœagus with two or more cornuti; harpes densely armed distally with short spines........10.
8. Harpes very simple, club-like, armed with one patch of spines........9.
Harpes foot-like, armed on "heel" and "toe" with spines........*cypris.*
9. Distal process double........*rurina.*
Distal process single........*virgo.*
10. Distal process much longer than marginal process; harpes usually club-like. *argante.*
Distal process about as long as marginal process; harpes usually foot-shaped. *agarithe.*

11.	Harpes blade-like, serrate-edged	13.
	Harpes not blade-like	12.
12.	Harpes a single bent rod	*orbis.*
	Harpes biramous	*godartiana.*
13.	Uncus trifurcate at tip	*hartonia.*
	Uncus simple at tip	*statira.*

Color Key to Identification of Males

1.	Species tailed	13.
	Species without tail	2.
2.	Under side of forewing with spots arranged in a straight, diagonal line	3.
	Underside of forewing otherwise	4.
3.	Ground color orange	*agarithe.*
	Ground color yellow	*trite.*
4.	No sex-patches at bases of wings	5.
	Sex-patches at bases of wings	6.
5.	Yellow, narrow, chalky marginal band	*eubule.*
	White, lemon-yellow toward base. broad, chalky marginal band.	*statira* f. *etiolata* and *f. schausi.*
6.	Secondaries with long, hair-like scales at base	7.
	Secondaries without such a fringe of "hair"	8.
7.	Almost immaculate beneath	*agarithe maxima.*
	Not immaculate beneath	*argante.*
8.	Broad, chalky, scaled, marginal band extending about halfway across the forewing	11.
	Chalky margin may be broad apically but narrow at the outer angle of the forewings	9.
9.	Much red scaling across the disc of the forewing	*avellaneda.*
	Some orange scaling across the disc of the forewing	10.
10.	With a large black spot on the discoidal vein of the forewing; from the Antilles.	*thalestris.*
	Without such spot, or with the spot greatly reduced; mainland	*philea.*
11.	Ground color of forewing same as of hind wing	*statira, hartonia.*
	Ground color of forewing not the same as of hind wing	12.
12.	Forewing with orange spot	*orbis.*
	Forewing with yellow spot	*godartiana.*
13.	Marginal, chalky scales of hind wing appearing to be same color as other scales	14.
	Marginal, chalky scales of hind wing appearing lighter colored than other scales.	*cypris.*
14.	Central American	*intermedia.*[1]
	South American	*rurina.*[1]

The females are so variable and so little known, that I prefer not to key them as yet. Dr. Forbes's paper contains as adequate a key as is possible to construct from our present knowledge.

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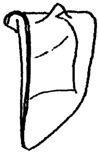
[1] Although genitalically different, I am unable to find any consistent color characters with which to separate these forms. See figures 29 and 32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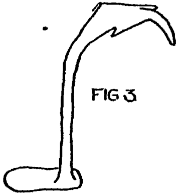
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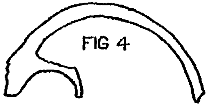
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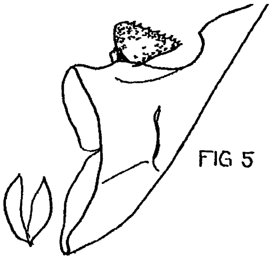
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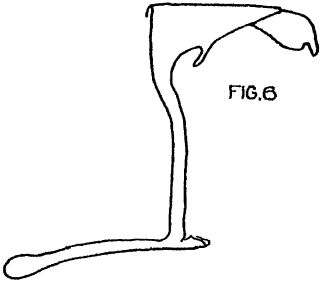
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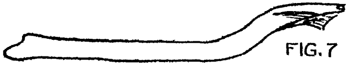
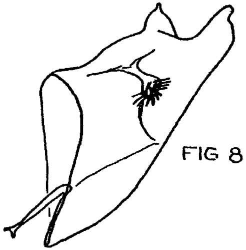


FIG.7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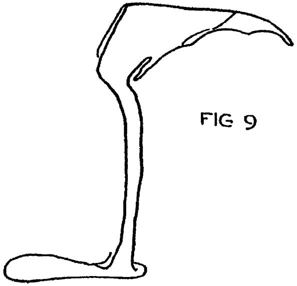
FIG 9

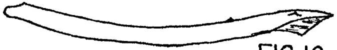
FIG.10

2. Valva of *Catopsilia crocale*.
3. Uncus, etc., of *Catopsilia crocale*.
4. Ædœagus of *Catopsilia crocale*.

5. Valva of *Aphrissa statira*.
6. Uncus, etc., of *Aphrissa statira*.
7. Ædœagus of *Aphrissa statira*.

8. Valva of *Phœbis eubule*.
9. Uncus, etc., of *Phœbis eubule*.
10. Ædœagus of *Phœbis eubule*.

Phœbis Huebner

This large genus may be divided into five groups of species, four of which have at times been given separate generic or subgeneric standing. Of these subgroups, only *Rhabdodryas* Godman and Salvin seems worthy of recognition, apart from *Phœbis* proper as a subgenus. The salient characters of the male armature may be briefly set forth as follows:

Valvæ crudely subtriangular; harpes prominent (differing from *Catopsilia*); distal process prolonged (quite short in *eubule*, *rurina*, and obscure in *avellaneda*); marginal process prominent (except in *trite*); annellus slender; juxtæ broadly filamentous, never leaf-like (differing from *Catopsilia* and *Aphrissa*). Uncus and saccus each simple and about equal in length (saccus the longer in *trite*), no dorsal lobe on the uncus (differing from *Catopsilia*); scaphium absent; vinculum slender. Ædœagus slender, straight or undulating, never sickle-shaped as in *Catopsilia;* distal end semi-lanceolate; several cornuti in the distal portion.

The palpi of both sexes are short and thick (differing from *Aphrissa*). The margins of the wings of the males broadly bordered with mealy scales varying in width with the species. The males with a sex-patch or pencil of hair, or both, above the subcosta of the hind wings, except in *eubule* which has neither, and in *philea* and *avellaneda*, where sex-patches are found on both wings.

The division of the group into subgenera has usually been based on the extent of the mealy scales on the wings and the various combinations of sex-patches and hair-pencils at the bases of the wings. If we were to accept all of the subgenera proposed, it would not be long before each species would stand alone in a subgenus of its own. It is unfortunate that many of the modern taxonomists can not recognize slight structural differences as specific, but must erect a new subgenus or genus to accommodate them. With the species concept broadening and the generic narrowing, it may not be long before the ultra-taxonomist will find the term species synonymous with subgenus.

There are apparently eight groups of forms in this genus that are sufficiently different to be considered species. They are *P. eubule, P. philea, P. avellaneda, P. argante, P. agarithe, P. rurina, P. neocipris,* and *P. trite*. In addition to the notes upon the male armature and the descriptions of newly recognized forms, I have included short discussions of the forms and races. The general laws of zoölogical nomenclature have been followed throughout. The races have been named by carefully considering material from the type localities when available.

Phœbis eubule Linnæus

Valvæ crudely subtriangular; distal process short, bicuspid, the inner spur always prominent, the outer usually obscure and smoothly rounded, rarely equally prominent; marginal process always present, variable in outline, usually blunt or flat-topped, occasionally devoid of the terminal thorn, rarely acutely triangular; harpes small, simple, slightly curved, distal portion armed with many short, sturdy, loosely attached spines notched at the tip. Uncus rather long and slender, the distal end prolonged into a long curved digital process varying slightly in proportion and degree of curvature; vinculum rather heavy; saccus stocky, about as long as the uncus. Ædœagus straight or slightly curved, usually slender; two cornuti in the distal third.

An analysis of about one thousand specimens with data, in The American Museum of Natural History, the Museum of Comparative Zoölogy, and the author's collection results in the following considerations.

P. eubule and its related forms are found throughout the entire American tropics and extends well into the north and south temperate zones. As might be expected, such a wide distribution over diverse areas has caused considerable variation and given rise to several races. Those inhabiting the eastern United States may be referred to as *P. eubule eubule* Linnæus. This has two forms, the nymotypical appearing in the southern states in the spring and autumn, and form *drya* Fabricius occurring throughout the racial range in the latter season. The last-named form is the one taken in the northeastern states. The under surface of the males of *drya* shows only a few traces of the normal markings, and the females similarly show a great reduction and usually some slight suffusion of the markings. The types of both forms were probably taken in the Carolinas.

The Antillean race, *P. eubule sennæ* Linnæus, is readily distinguished by the intensity of the markings as well as the distribution. The females are particularly recognizable by the submarginal and subcostal row of brown spots on the upper surface that is always present, rarely only in traces. In addition, the marginal markings terminating the nervures are much heavier, and in the forewing usually form a continuous band serrate on the inner edge. Below, both sexes show a very definite series of fine, short, wavy, Indian-red lines covering the entire hind wing and the marginal and costal areas of the forewing through which the pattern distinctly shows. Occasionally these lines are faint. Linnæus' type was from Jamaica.

The tropical race, as used here, extending from central and northern South America through Central America and Mexico to Arizona may possibly represent two races. I have, however, been unable to find tangible characters that will separate them. This race may be called *P. eubule marcellina* Cramer. To it I refer *pallida* Cockerell for the females in which the ground color has been reduced to white; *yamana* Reakirt is merely an intermediate transitional to *pallida*. The race *P. e. marcellina* differs from the preceding in that the typical females are much more intensely marked, the hind wings often being orange in color, a thing rarely, if ever, occurring in *sennæ* or *eubule*. Females of this race are found in almost any shade between the dark burnt-orange of occasional specimens and the pure white of the typical *pallida* form. The males are lighter colored than the females and show considerable marking beneath. The fully typical *marcellina*, as figured by Cramer, is rare. I have seen but one, from Honduras, in a series of several hundred of this race. The male abberation *schausi* Oberthür belongs to this race. The name applies to those males in which the markings of the underside of the hind wings are suffused across the disc and form a row of broad marks extending toward the base.

The forms from the southern part of South America closely resemble the race *P. eubule eubule* and live under similar climatic conditions. To this race I apply the name *amphitrite* Fiesthamel (not Blanchard as stated by Butler). It was described from Chili. *P. giacomelli* Köhler is merely a very small male and from the scant description is of the typical form. A future paper will be devoted to a more thorough study of the synonymy and biologic relationship of the forms of this species.

These various races and forms may be catalogued as follows:

a. *Phœbis eubule eubule* Linnæus (North Temperate race)
  f. *drya* Fabricius
b. *Phœbis eubule sennæ* Linnæus (West Indian race)
  f. ♀ *sennalba*, new form
c. *Phœbis eubule marcellina* Cramer (Tropical race)
  f. ♀ *pallida* Cockerell
  ab. ♂ *schausi* Oberthur
d. *Phœbis eubule amphitrite* Feisthamel (South Temperate race)

Phœbis eubule sennæ female form **sennalba,** new form

ABOVE.—White, with faintly greenish or buff cast. Margin of forewing narrowly brown, serrate on the inner edge, indentations in border at terminals of nervures. Apex and costa brown, decreasing in intensity along the costa toward the base; a subcostal row of three and a submarginal row of five or six patches of brown scales decreasing in intensity toward the anal margin; discal spot on vein between M_2 and M_3. Margin of hind wings with patches of brown scales at the terminals of the nervures, patches almost contiguous.

BELOW.—Very faintly greenish yellow, except the anal area of the forewing which is white, and the very base of both wings which is buff-yellow to light cadmium-yellow. Maculation as in typical females, except lighter and more diffuse. No fine wavy lines of Indian red as in the typical females.

HOLOTYPE.—Female, taken 7 kilometers north of Viñales, Cuba, September 16–22, 1913, (Lutz).

PARATYPES.—One female, Cristo, Ornte, Cuba, October 3, 1913, (Lutz); one female, San Juan, Porto Rico, July 1–5, 1915, (Lutz and Mutchler).

All types in The American Museum of Natural History.

The nymotypical *eubule* has been named as the type of the genus *Callidryas*. The following two species are usually considered members of this group. They have, however, been separated into a subgroup by Forbes, which he does not consider worthy of a name. The separation is based on the scaling.

Phœbis philea Linnæus

Valvæ subtriangular, distal process greatly prolonged (shorter in race *thalestris*) and rather of uniform width throughout, bluntly tipped; marginal process an acute anteriorly curved spur (not quite so prominent in *thalestris*); harpes large, usually T-shaped, rounded at the dorsal and pointed at the ventral end of the head, sometimes simply curved, heavily spined on the outer face, spines not notched; annellus slender; juxtæ narrowly blade-like. Uncus large and heavy, distal portion spatulate, abruptly terminating in a sharp spur; vinculum moderately heavy; saccus about as long as the uncus and moderately heavy. Ædæagus slender and rather straight, distal end flaring slightly, armed with a single cornutus near the tip and a second cornutus on the very tip, often obscure and easily overlooked.

The synonomy of this rather large and interesting species is somewhat lengthy, since many of the early authors based their names on the variable marginal markings. The following are synonyms of the female *philea: aricye* Cramer, *arica* Godart, and *fornax* Butler. Forbes applies *editha* Butler (female only) to the Santo Domingo race of *thalestris*, but I consider it a seasonal form. The albino female of *philea* has been named *obsoleta* by Niepelt. There are three synonyms for the male *philea*: *corday* Hübner, *lollia* Godart, and *larra* Fabricus. D'Almeida considers that *melanippe* Cramer should be applied to the spring form in the southern extreme of the range.

The status of *thalestris* Illiger is slightly doubtful in my mind. It may be worthy of specific recognition or may be only a very well-differentiated race. I am inclined to the latter concept, as there are intermediates between it and *philea*. There is a particularly good intermediate male in The American Museum of Natural History that was bred in Haiti by

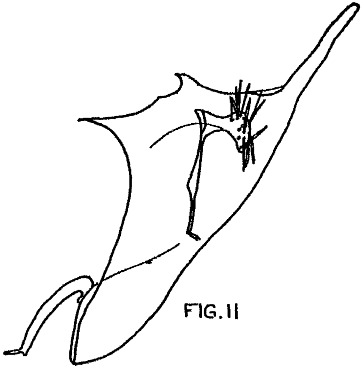
FIG. 11

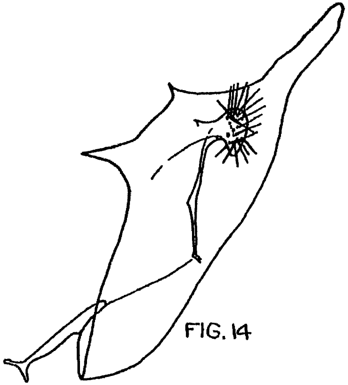
FIG. 14

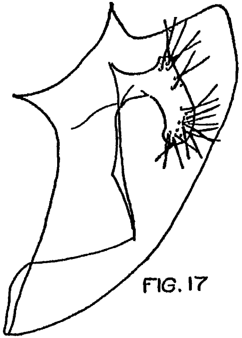
FIG. 17

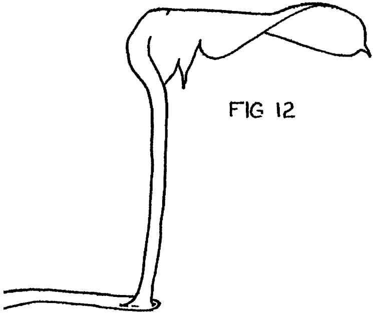
FIG 12

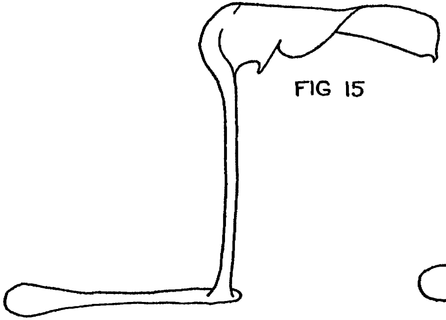
FIG 15

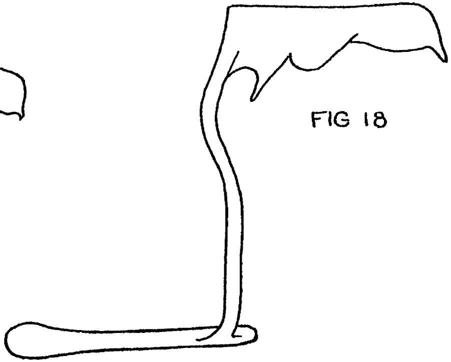
FIG 18

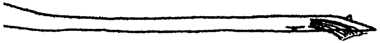
FIG. 13

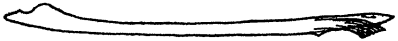
FIG. 16

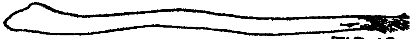
FIG. 19

Mr. Frank E. Watson. The careful breeding of both *philea* and *thalestris* will probably be the only solution to the riddle.

The forms may be catalogued as follows:

a. *Phœbis philea philea* Linnæus (Mainland race)
    f. ♀ *obsoleta* Niepelt
    gen. vern. *melanippe* Cramer
b. *Phœbis philea thalestris* Illiger (West Indian race)
    f. temp. *editha* Butler

Phœbis avellaneda Herrick-Schaeffer

Valvæ subtriangular; marginal process an acute spur situated in about the middle of the dorsal margin; distal process lacking, or so uniform with the slightly acute but rounded dorsal posterior angle of the valva as to be indiscernible; harpes large and heavy, with a double bend, armed with long, heavy spines on the outer face; annellus slender and long, juxtæ short and narrow. Uncus large and heavy, distal end spatulate, ending in a short, hooked spur; vinculum slender; saccus large and heavy, slightly longer than the uncus. Ædœagus moderately heavy and rather straight, distal end armed with a single cornutus, possibly a second.

There is only the typical form of this species known. It hails from Cuba. Butler described a species, *solstitia,* from Chili, which is in no way different from *avellaneda.* I strongly doubt the validity of the locality datum for *solstitia.*

Phœbis argante Fabricius

Valvæ crudely subtriangular; distal process long, hooked at the tip; marginal process a prominent spur, occasionally blade-like; a secondary marginal process at the base of the distal process; harpes small, simple, slightly bent, rarely angular, heavily armed with short, slender spines at the distal end and along the ventral surface; annellus slender; juxtæ slender and tapering. Uncus moderately large, long and slender, terminating in a digital process; vinculum prominent on the uncus, slender; saccus slender and about as long as the uncus. Ædœagus slender, undulating, distal end sharply curved; two cornuti about one-third the distance from distal end and set in low eminences.

There is, apparently, no consistent variation in the male armature throughout the range of this species; forms *hersilia* and *rorata* differ in no respect from *argante.* Specimens were examined from Cuba, Santo Domingo, Haiti, Mexico, Honduras, Costa Rica, Panama, Venezuela, Brazil, Colombia, Bolivia.

There are two well-defined races: one on the mainland, the other in the West Indies. It is apparent, also, that the mainland form is differentiating to the north and south, and that there will be in time three mainland races, as we find in *eubule.* To the parent race on the mainland I apply Fabricius' name *argante* and to the insular race *rorata* Butler, first applied to an albino female from Haiti. Again, as in *eubule*, the females show the racial differences more distinctly than the males. The upper surface of *rorata* females usually is heavily overlaid with Indian-red scales and shows several differences in the dark markings, primarily the reduction of black-brown on the apex, the increased scaling of the diagonal submarginal bands, and the reduction of the marginal band to a series of spots. Beneath, the markings are intensified throughout and usually with little or no pearly scaling. The males often are more heavily marked beneath than the typical *argante*, which type they resemble on their upper surfaces. Then, too, in the males there is found silver scaling in the discal spot of the under side of the hind wings. I have seen only one *argante* male in which this spot, usually golden, is silvery—a small specimen from Tezonapa, Mexico, in the collection of The American Museum of Natural History. Forms *rorata* and *hersilia* are similar in this respect.

Two forms of the mainland race occur: the nymotypical *argante* and Cramer's *hersilia*.[1] In studying a series of about two hundred specimens from over the entire range of this insect, it became apparent at once that *hersilia* is the dominant tropical form and *argante* the dominant form in the north and south. Form *hersilia* is gradually separating itself from the *argante* type and forming a purely tropical race that will be flanked on the north and south by forms similar to our present *argante*. In this case the difference in forms is apparent in the males—the marginal row of black dots having become confluent and having formed a black band in *hersilia*. However, only about forty per cent of the specimens from the northern part of South America show a complete band, but only one to two per cent show no trace of this band. There is a transitional group of about seventy per cent of all the males in the collections I have examined. The form *hersilia* ranges from Honduras to Bolivia—almost the entire range of the mainland race.

Butler has named a miniature male *miniscula*, in the Kaden collection, from Havana; it appears wherever *argante* flies, as it is merely a very small specimen. The differences in color noted by Butler do not hold for all specimens.

In the tropics there appears an albino female, probably of form *hersilia*. I call it *Callidryas argante argante* female form *albante*.

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[1] Butler has noted that *cipris* (female) Cramer has page priority in the case of *hersilia*, but since there is a Fabrician species of the same name, *cipris*, he uses *hersilia*.

Callidryas argante argante female form **albante,** new form

ABOVE.—White, with a very faint yellow area at the margin of the wings extending not much beyond the brown marginal patches. On the forewings the marginal patches are terminal to the nervures and not joined to make a band; the apex is narrowly black-brown and the same color extends along the edge of the costa; there are three subcostal spots and five submarginal spots (the middle one very faint and out of line); the submarginal spot between M_2 and M_3 on the hind wing is faintly represented.

BELOW.—Bright cadmium yellow, a little darker at the bases of the wings. The pattern is distinct and Indian red in color with some blue and pearly scaling. The usual wavy red lines are few and scattered and do not cause the pattern to become suffused.

HOLOTYPE.—Female, Tegucigalpa, Honduras, June 30, 1918, (F. J. Dyer).

Type in The American Museum of Natural History.

Huebner's *cypris* is transitional to this form with the markings much more intense and on the upper surface of the forewing coalesced.

Schaus's *clarki* is, I believe, merely a large female from Mexico.

The normal yellow female of race *rorata* may be called normal female form **adela**, new form.

The forms may be listed as follows:

Phœbis argante argante Fabricius (Mainland race)
  f. *hersilia* Cramer
  f. ♀ *albante*, new form
Phœbis argante rorata Butler (West Indian race)
  f. norm. *adela*, new form

Phœbis agarithe Boisduval

Valvæ subtriangular; distal process short, slightly hooked; marginal process prominent, slenderly tapering at the tip or blade-like; secondary marginal process small but prominent; harpes large, bent, often foot-like with many long, hairy spines especially at the distal end; a secondary harpes is present at the base of the dorsal point of attachment. It is usually obscure, a mere fold armed with three or four heavy spines; occasionally it is heavily chitinized and then noticeable. These heavily chitonized specimens are found throughout the range; annellus moderately slender; juxtæ short and blade-like. Uncus moderately long and terminating in a short, slightly curved digital process; vinculum slender; saccus slender and about as long as the uncus. Ædœagus undulating, tapering to the distal end; two cornuti, one-fourth the length from the distal end.

There is not much apparent variation in the genitalia throughout the range of this species. Specimens examined from Florida, Cuba, Jamaica, Haiti, Mexico, Colombia, Brazil.

The combined series of this species that I have been able to study numbers a little more than one hundred. Two races are usually accepted;

there is, however, a third that is recognizable, and possibly a fourth. *P. agarithe agarithe* Boisduval is the mainland form found throughout neotropical and subneotropical South America. Apparently, it is less abundant on the mountainous western coast than elsewhere. *P. agarithe maxima* Neumoegen is found in the region bordering the Gulf of Mexico from Florida to Southern Mexico, and possibly well south in the isthmus of Central America. *P. agarithe antillia*, new subspecies, is the West Indian race and is found throughout the Antilles. *P. a. maxima* is easily recognized by the great decrease in reddish-brown markings on the under surface, as compared with either of the other races, making a form

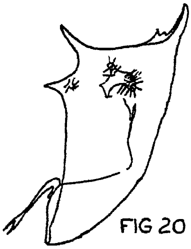
FIG 20

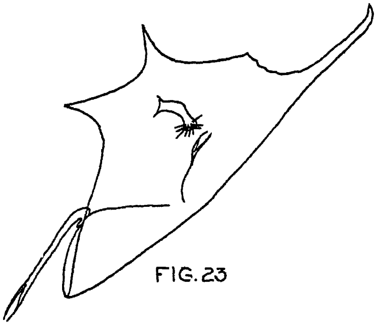
FIG. 23

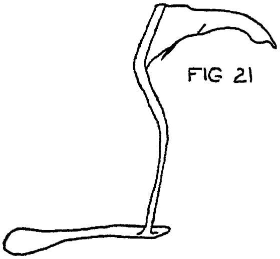
FIG 21

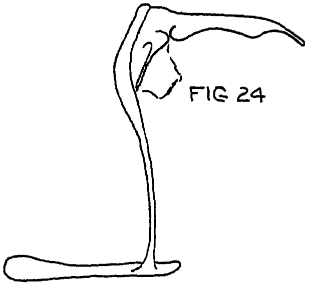
FIG 24

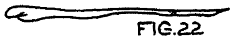
FIG. 22

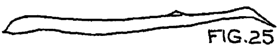
FIG. 25

20. Valva of *Phœbis agarithe.*
21. Uncus, etc., of *Phœbis agarithe*
22. Ædœagus of *Phœbis agarithe.*
23. Valva of *Phœbis argante.*
24. Uncus, etc., of *Phœbis argante.*
25. Ædœagus of *Phœbis argante.*

more clearly and sharply marked. The black dots terminating the nervures on the upper surface are reduced to a minimum and in no case before me are they run together on the apex to form a continuous line as is often the case in *agarithe* and *antillia*. The race *antillia* is characterized by a great amount of Indian-red scaling on the under surface, arranged in wavy lines, as in *P. e. sennæ*. This scaling is usually distinctly visible through the wing from the other side. *P. a. agarithe* shows this scaling to some degree, but I have not as yet seen one with markings as intense as the least intense specimen of *antillia*. In 1883, Henry Edwards described a female of this group as *Callidryas fischeri;* it is either a small *maxima* or a race that has developed in Lower California. The type and a male are in the collection of The American Museum of Natural History and are the only specimens I have seen from Lower California, hence I am not willing to take a definite stand; they differ considerably from the normal and I feel that additional material will show them to be a good race.

I append the description of the Antillian race and of an unnamed albino female.

Phœbis agarithe antillia, new subspecies

MALE

ABOVE.—Dark chrome-yellow, secondaries lighter than primaries toward the base; nervures tipped with a few black scales except on the costal margin of the apex, where the black scaling forms a short, discontinuous line.

BELOW.—Chrome-yellow, except inner margin of the forewing which is paler, covered with short, wavy lines of Indian-red scaling; diagonal line and three apicocostal spots of the same color on the forewing; discal spots small but intensely marked.

FEMALE

ABOVE.—Chrome-yellow, dusted with Indian red over the costal and cellular region of the primaries and the entire secondaries where the dusting is most marked along the margin; aggregates of brownish-black scales on the tips of the nervures of the forewing and less noticeably so on the hind wing; apex broadly tipped with blackish brown; a blackish-brown discal spot on the forewing; diagonal stripe on under side distinctly noticeable.

BELOW.—Chrome-yellow, heavily overlaid with wavy lines of reddish purple; discal spots large and silvery, rimmed with purple.

HOLOTYPE.—Male, Pivert, Haiti, April 1, 1922, (Watson).

ALLOTYPE.—Female, Fond Parisien, Haiti, February 11–18, 1922, (Watson).

PARATYPES.—One male, Caymanas, St. Catherine, Jamaica, November 23, 1919, (Watson); one male, Two Mile Wood, St. Catherine, Jamaica, Nov. 14–23, 1919, (Watson); one male, Fond Parisien, Haiti, February 11-18, 1922, (Watson); one male, Santiago, Cuba, February, 1892, (Schaus).

Types in The American Museum of Natural History.

The genitalia figured are of the type.

Phœbis agarithe maxima female form **albarithe,** new form

ABOVE.—White, usually so overscaled with reddish as to appear pink; the black-brown marginal markings a little more suffused than in the typical females and perhaps a little larger than the average; submarginal row of patches in the fore-wing marked and present between M_2 and Cu on the hind wing.

BELOW.—Pearly; reddish scaling greatly reduced in comparison to typical form; marginal and submarginal markings rather faint, discal spots narrowly margined.

HOLOTYPE.—Female, Jalapa, Mexico, (Schaus).

PARATYPES.—Two females, Jalapa, Mexico, (Schaus). One female, Nueces River, Texas.

Types in The American Museum of Natural History.

The forms of this species then are:

Phœbis agarithe agarithe Boisduval (South American race)
Phœbis agarithe maxima Neumoegen (Gulf Region race)
    f. ♀ *albarithe,* new form
Phœbis agarithe fischeri Henry Edwards (Lower Californian race)
Phœbis agarithe antillia, new subspecies (West Indian race)

The various forms constituting the tailed group of this genus are very similar and easily confused; there are two good species and probably a third. I shall consider them as three species: *cypris, rurina,* and *intermedia.* The first is confined to the southern subneotropical regions and ranges through northern Argentine, Uraguay, southern Brazil and, rarely, into Bolivia; the second, *rurina,* is found in Peru, Ecuador, Colombia, Venezuela, the Amazon basin of Brazil and the Guianas; the third, *intermedia,* ranges from Costa Rica to southern Mexico.

Phœbis cypris Fabricius

Valvæ subtriangular; distal process moderately long, tipped with a small, hooked spur; marginal process prominent, a tapering spur; secondary marginal process lacking; harpes foot-like, long, heavy spines abundant at the "heel" and "toe"; annellus very slender; juxtæ very slender. Uncus rather short for the group, stocky, terminating in a long, curved digital process; vinculum slender; saccus slender, as long as, or a little longer than the uncus. Ædœagus slender and undulating two conspicuous cornuti about one-third the length from the distal end.

There is some variation in the coloring in this, the smallest member of the group. The males may be practically a dull yellow monotone or rather deeply flushed with orange on the disc of both wings. These last superficially resemble *rurina.* I believe that, with sufficient material with the date of collection it will be found that the two phases are wet

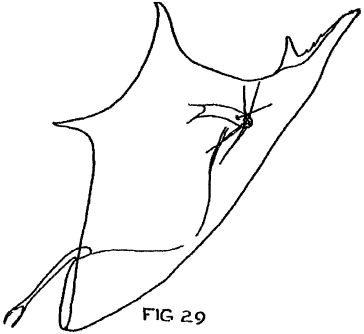
FIG 29

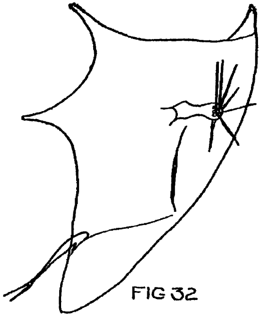
FIG 32

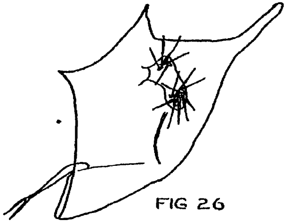
FIG 26

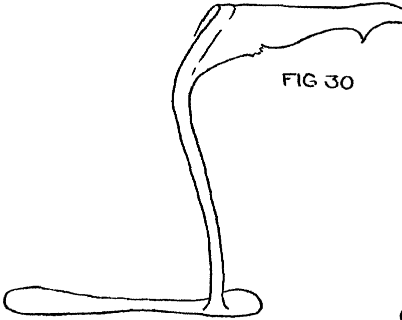
FIG 30

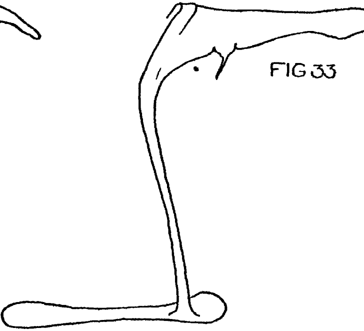
FIG 33

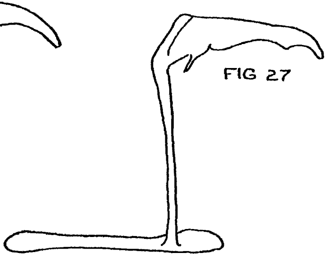
FIG 27

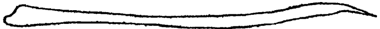
FIG 31

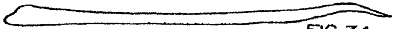
FIG 34

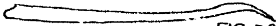
FIG 28

26. Valva of *Phœbis cypris.*
27. Uncus, etc., of *Phœbis cypris.*
28. Ædœagus of *Phœbis cypris.*

29. Valva of *Phœbis rurina.*
30. Uncus, etc., of *Phœbis rurina.*
31. Ædœagus of *Phœbis rurina.*

32 Valva of *Phœbis intermedia.*
33. Uncus, etc., of *Phœbis intermedia.*
34. Ædœagus of *Phœbis intermedia.*

or dry—or, more correctly, spring and summer generations. To this species I refer *irrigata* Butler, *bracteolata* Butler, and *neocipris* Huebner. The light form may be called *cypris* Fabricius; the dark, *neocipris* Huebner.

Phœbis rurina Felder

Valvæ subtriangular; distal process short, terminating in a short, hooked spur; marginal process prominent; secondary marginal process at the base of the distal process small but prominent; harpes simple, straight, knobbed at the end, knob armed with several long, heavy spines; annellus short; juxtæ broad, blade-like. Uncus long, slender, well differentiated from the vinculum, terminating in a long, straight digital process; vinculum slender; saccus slender; about as long as the uncus. Ædœagus long and slender, undulating; two cornuti about two-fifths the length from the distal end.

This striking species has escaped the usual synonymic muddle. It is very uniform throughout its range, which probably accounts for that. A Peruvian male specimen has of late been named *peruvicola* by Strand. I can find no difference between my series of Peruvian and Colombian materials. (*P. rurina* was described from Bogota, Colombia.) *P. peruvicola* may be considered a male abberation with abnormally large patches of brown on the under side of the wings. The female figured by Butler in his monograph is not at all the normal type which Felder figures in the the 'Reise Novara.' I have seen but one specimen that is of the type figured by Butler and but few intermediates to it among the twenty-five female specimens examined.

The following form may or may not be a full-fledged species; it may be merely a race of *rurina.*

Phœbis intermedia Butler

Valvæ subtriangular; distal process short, tipped with a hooked spur; marginal process prominent, a tapering spur; secondary marginal process absent; harpes simple, straight, knobbed, armed with several, long, heavy spurs on the knob; annellus stocky; juxtæ broad, blade-like. Uncus long and slender, terminating in a slightly curved digital process; vinculum slender; saccus slender and about as long as the uncus. Ædœagus slender, tapering to the distal end, undulating; two inconspicuous cornuti about one-third the length from the distal end.

The albinio female of this species has been named *virgo* by Butler.

The foregoing group may be listed as follows:

- *Phœbis cypris* Fabricius
  - f. temp. *neocipris* Huebner
- *Phœbis rurina* Felder
  - ab. ♂ *peruvicola* Strand
- *Phœbis intermedia* Butler
  - f. ♀ *virgo* Butler

The following species, *Phœbis trite*, is sufficiently removed from the preceeding groups to be considered a distinct subgenus, *Rhabdodryas* Godman and Salvin. In all manner of structure it is intermediate between *Phœbis* and *Aphrissa*, but with a much stronger relationship with *Phœbis* than with *Aphrissa*. In the genitalia of the males it is apparent in the position of the harpes and the absorption of the marginal process. However, the juxtæ definitely ally it with *Phœbis*.

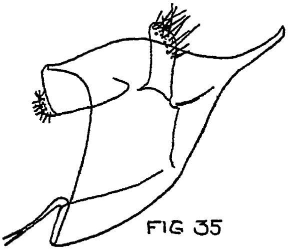

FIG 35

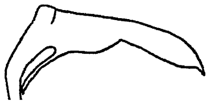

FIG 36

FIG 37

35. Valva of *Phœbis* (*Rhabdodryas*) *trite*.
36. Uncus, etc., of *Phœbis* (*Rhabdodryas*) *trite*.
37. Ædœagus of *Phœbis* (*Rhabdodryas*) *trite*.

Phœbis (Rhabdodryas) trite Linnæus

Valvæ subtriangular; distal process moderately long, terminating in a slightly curved hook; dorsal margin smoothly curved; marginal process lacking; harpes very large, straight or slightly bent, projecting dorsally beyond the margin of the valvæ, dorsally armed on the posterior surface with several, long, heavy spines; anterior margin of the transilla, terminating in a tuft of heavy, easily detached spines (*labides?*); annellus moderately heavy; juxtæ narrow. Uncus very simple and slender, terminating in a very short curved spur; vinculum slender; saccus slender; about one and one-half times as long as the uncus. Ædœagus slender, straight or slightly curved; five or six inconspicuous cornuti in the distil half, the outermost being most prominent.

This species is primarily a neotropical species, rarely finding its way into the subneotropical regions. Heretofore, no forms or races have been described. However, an examination of a large series from the entire range of the insect shows that there are two distinct races: one on the mainland and the other in the West Indies. The Antillean race is easily distinguished from the mainland race by the absence of the black marginal markings and the reduction of the markings on the underside to a minimum. In the first respect, this forms is similar to the one found principally in Southern Brazil, but the latter has the underside normally marked. The former I call race *watsoni* and the latter form *banksi*.

Phœbis (Rhabdodryas) trite watsoni, new subspecies

MALE

ABOVE.—Similar to *trite* but lacking entirely the black margin of the forewing and hind wing.

BELOW.—Ground color citron-yellow instead of light buff, as in *trite*. Maculation reduced to a minimum; the diagonal lines, characteristic of the species, very faintly represented by a few brown scales; the patches between M_2 and M_3, and M_3 and Cu on the hind wing each represented by fifteen or twenty scattered brown scales.

HOLOTYPE.—Male, Sanchez, Santo Domingo, W. I., May 28–31, 1915, (Watson).

PARATYPES.—Two males from Cayey, Porto Rico, W. I., May 30–31, 1915, (Lutz and Mutchler); one male from Adjuntas, Porto Rico, W. I., June 8–13, 1915, (Lutz and Mutchler).

Types all in The American Museum of Natural History.

Phœbis (Rhabdodryas) trite trite form female **tralba,** new form

ABOVE.—White with greenish-buff cast; brownish marginal stripe as in typical females on both forewing and hind wings.

BELOW.—Very light buff; maculation as in normal females.

HOLOTYPE.—Female, Inca Mines, Peru, September 29, 1900.

Type in The American Museum of Natural History.

Phœbis (Rhabdodryas) trite trite form **banksi,** new form

MALE

ABOVE.—Similar in *trite*, but completely lacking the black marginal markings.

BELOW.—As in *trite*.

HOLOTYPE.—Male, Santa Catherina Province, Brazil.

PARATYPES.—Nine males, Santa Catherina Province, Brazil.

Holotype and eight paratypes in the Museum of Comparative Zoölogy, Harvard University; one paratype in The American Museum of Natural History.

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agarithe Boisduval, 1836, 'Spec. Gen.,' I, p. 623.

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albarithe (*agarithe*), new form.

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clarki (*argante*) Schaus, 1920, Proc. U. S. N. M., LVII, p. 109.

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[1] **The names in brackets refer to the species under which the form is discussed.**

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AMERICAN MUSEUM NOVITATES

Number 369
Published by
The American Museum of Natural History
New York City
Sept. 6, 1929

59 7, 55 S 12 93

AN UNUSUALLY LARGE (53 MM.) TWO-HEADED BROOK TROUT, *SALMO FONTINALIS*

By E. W. Gudger

In May, 1925, I learned that Mr. A. A. Townsend, fish culturist at Yama Farms Brook Trout Hatchery, Napanoch, N. Y., had an unusually large two-headed young trout which he was rearing by hand. I at once wrote Mr. Townsend saying that since, such teratological fishes never survive long, I would after its death very much like to have this specimen for study. He kindly replied that when this took place he would send me the fish. And on November 2 there came to me the two-headed trout shown in dorsal and ventral views, respectively, in Figs. 1 and 2.

Double-headed fish embryos are not uncommon. Every fish hatchery handling large numbers of eggs has a few every hatching season. Hence, it would seem unnecessary to describe this particular specimen but for the fact that it has grown to the unusual size of 53 mm.—outside or "over all" measurements. As will be seen later, not many grow to this size and few larger, and this only in hatcheries where they are artificially fed. In the wild state such fish, even if they survive hatching, soon fall prey to their enemies, because of their inability to move rapidly through the water.

The measurements of this little monster, after being in alcohol for over 3½ years are as follows: length from tip to tip 53 mm. (note that the left head is the larger and that it is used for taking measurements), length to point of junction (dorsal) 18 mm., to point of junction (ventral) 12 mm., to base of anal fin 30 mm., to base of caudal 42 mm.; width between inside eyes 3 mm., between outside ones 17 mm.

The bodies are separate for slightly less than one-third of the standard length (12 out of 42 mm.), but as usual one head (in this case the left) is slightly larger. Each dorsal fin starts on its own body but ends on the common tail. Each fin, however, is separate even to the hinder portion, although the hinder thirds are separated by a mere groove. This groove extends along the dorsum slightly beyond the adipose dorsals. These begin as separate structures each on its own side of the groove but become united behind into one structure. However, just before the point of junction each has a small wing-like lappet about where the highest point would be in a normal adipose fin. The paired adipose fins are visible in Fig. 1 but not the united terminal portion. The inner lateral lines come together at the point of junction of the two heads. Extending backward from this point until lost between the two dorsals is a raphe quite distinct from the lateral line structures.

The outer sides of this little monster possess no abnormal structures, the pectoral fin and lateral line of each being seemingly entirely normal. The ventral surface, however, has a groove running back from the point of junction of the two heads along the mid-ventral region to the anus. It cannot be said how much this groove, like the dorsal one, may be accentuated by reason of the long stay in the preservative. The ventral fins are two, closely opposed along the sides of the groove but wholly separate in origin. The anal fin shows no trace of duplication. The doubling then extends much farther back on the dorsum than on the venter.

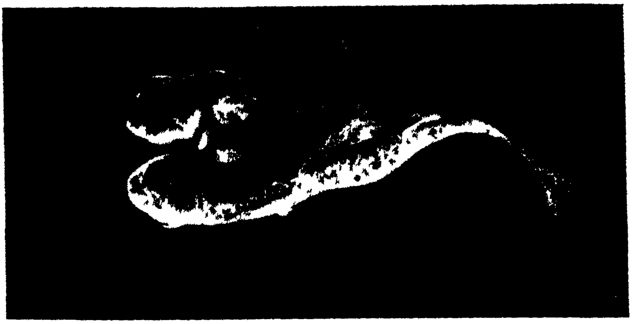

Fig. 1. A double-headed young trout, 53 mm. (2.12 in.) in total length, seen from above. The bifurcation measures 18 mm. out of 42 mm. standard.

In the region between the two heads are to be found the greatest evidences of abnormality. Seen from above the two inner pectorals are closely opposed and point backward and sharply upward at an angle of about 75°. This has prevented the gill covers from lying flat in their normal position, they being curled forward, the right much more than the left. However, the gills on the left head (four sets of them) are much more visible than those on the right, perhaps because of the better development of the left head. These points may be made out in Fig. 1 by using a glass.

Viewed from below, the left head appears quite normal even in the appearance of the inner or right gill cover. Serious disturbances are visible in the hyoid region of the right head. The hyoid parts are so displaced downward and forward as to come to lie in the general plane of the underside of the body. This has caused the gill covers on the inside of the right head to gape widely and to reveal the gills. How much of this is natural and how much is artifact due to contracting and hardening in alcohol is impossible to say. These points are clearly brought out in Fig. 2. The mouth on the left head is larger and more normal than that on the right one.

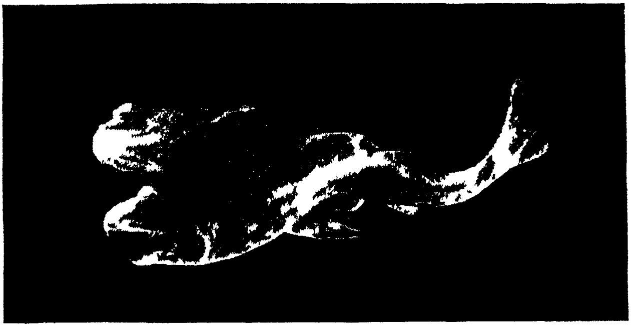

Fig. 2. Ventral view of the same fish. Note that the bifurcation extends backward for a shorter distance (12 mm.) than on the dorsum. Note also the distortion of the hyoid region of the right head and the smaller mouth on this head.

As to the history of the monster shown in Figs. 1 and 2, I am privileged to quote Mr. Townsend as follows:

> This little two-headed brook trout was hatched in February, 1925, and died on November 2nd of the same year—9 months later. I kept it in a small box 2 feet long, 8 inches wide, and 9 inches high. I kept the water at a depth of about 5 inches in the box with a flow of about a quart a minute going through it. The only diet of the little fish was fresh pig's liver ground through a 5/64ths inch plate of an Enterprise meat chopper five times. It died with a fungus growth on the gills. This was caused by the larger [left] head working the smaller head into the sand at feeding time. This was kept up until inflammation set in in the gills of the smaller head, then fungus came and killed it.

It seems not improbable that the abnormal condition of the hyoid region of the right head seen in Fig. 2 may, in part at least, be due to this fungus infection. While both the size (53 mm.) and the age (9 months) of this specimen are unusual, Mr. Townsend writes me that he has raised two larger ones by isolating them and feeding them carefully.

The first of these reached a length of 5 inches (127 mm.) and an age of about 11 months. Of the other he writes:

> The other little two-headed trout lived 11 months and grew to be 5 ⅛ inches long [130 mm.]. It was kept separate in a box as was the one I sent you, and when it grew pretty large was transferred to a larger box. While I was away for a few days, a heavy thunderstorm came up and flooded everything and, as the attendant forgot about it, the box and fish were washed away. One head was larger than the other and in feeding it dragged the other about on the bottom. This is the great difficulty in rearing two-headed fish. Whenever one head of the 5⅛ inch fish got sore by reason of the other head rubbing it on the bottom, I would take the fish out and put a mild solution of peroxide or iodine over the head and body at the same time protecting the eyes. This would always stop the growth of fungus. It was a perfectly healthy fish and if I could have kept it, I am sure that I could have raised it to be a large trout.

As will be seen in the next section, these three trout are the largest two-headed fishes of which we have records, and great credit is due Mr. Townsend for his patient care and marked success in rearing these fish.

HISTORICAL NOTES

There is no intention here of giving a review of the literature of bicephalism in fishes. The references are too numerous, there being forty-one direct ones to double monsters in the 'Bibliography of Fishes' and its continuation card catalogue. It would be a lengthy task to review even the twenty-four of this list which refer particularly or solely to the Salmonidæ. Furthermore, since all such double-heads resemble each other very closely, differing chiefly in the extent of bifurcation, the task would be a rather fruitless one. This large number of citations to this peculiar type of teratological phenomenon is, of course, due to the fact that fishes are extensively propagated by artificial hatching. And the fact that more than half of the references pertain to the Salmonidæ results from the further fact that these fishes are the ones most abundantly reared in hatcheries since they are of especial value for the restocking of streams in the interest of angling.

Frequency of Occurrence.—With reference to the frequency of occurrence of double monstrosities, the data is widely scattered and when brought together shows that there is much variation of its occurrence in any given species. The following statement is condensed from the great work of J. F. Gemmill,[1] references to the authors quoted by him being omitted for the sake of brevity. The reader interested in looking up these citations will find them given on page one of his work. For the Salmonidæ, the following figures are given: 1 double-head in 50 eggs, 1 in 200, 1 in 280, 1 in 350, 1 in 600, 68 in 900, over 100 in 400,000, while one investigator found as high as fifty per cent in one brood to be two-headed monsters. In *Perca fluviatilis*, two double embryos were found in a set of 40 eggs. In 203,962 eggs of the pike (*Esox lucius*) 222 double-heads were found, an average of 1 in 920. For this fish another investigator found 1 monster in a brood of 325 eggs, and another 6 in a hatch of 917 fishlets. And, finally, for *Petromyzon* there is a record of 40 eggs with twin gastrulæ out of a batch of 100.

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[1] 'The Teratology of Fishes,' Glasgow, 1912, 73 pp., 25 Pls., 6 text-figs. Folio.

On the other hand, examination of 4,000 eggs of *Cyprinus blicca* by an investigator interested in twin-heads showed not a single monster. Again, Stockard (to be referred to later), in 1921, stated that in fourteen, seasons' experimental work with the eggs of *Fundulus heteroclitus*, he had never found such monsters in many hundred control embryos. My own experience is of like kind. In four or five years hatching of thousands of eggs of the toadfish, *Opsanus tau*, I did not find a single double-head. Further, in six years' work with the orally incubated eggs of the marine catfish, *Felichthys felis*, involving the study of hundreds of eggs, I found but three monsters—one having three eyes (the third formed of two fused eyes) and two Siamese twins.

From the above, it must be concluded that this teratological condition in fishes is a relatively rare one. For a study of the relativity of occurrence, even in the same species, the conditions of temperature, purity of the water, crowding, etc., would have to be brought to the same standard. This, so far as I know, has never been done.

ADULT TWO-HEADED FISHES.—I have sought in vain for data on adult two-headed fishes. None of the references cited indicate by their titles unusual size in the fishes considered, nor is there any reference to large double-heads in Gemmill's great work. However, I have gone to the trouble of looking up all the references in the 'Bibliography of Fishes' in the hope that some of them might pertain to large double-heads. Practically all of these articles, however, have to do with embryos recently hatched, or else are discussions of the theories of origin of this abnormality. The oldest for which age was noted was four months, size not given, and the greatest size noted was 20 to 21 mm. (slightly under an inch), while the little fish under consideration is 9 months old and 53 mm. (2.12 inches) long over all. There may be accounts of larger specimens hidden in the general works in teratology but, if so, they have been overlooked by ichthyological teratologists.

What seemed a promising "lead"—more seeming than real—to an exception to the above statement was discovered in an article by A.

Audeville published in 1888.[1] This man, who operated a private trout hatchery, became interested in the abnormal embryos and like Mr. Townsend determined to try to rear some by hand, so to speak. He soon found that they habitually died at the time of resorption of the last remnant of the yolk, and he thought that his efforts were doomed to failure. However, he finally got one little double-head to feed at this critical period, and it was at once isolated and watched constantly. This little fish had two distinct and perfect heads attached just behind the eyes (unfortunately he gives no figure), and from there back a single body.

During the first weeks, the little fish fed freely and the two heads seemed to develop simultaneously and equally. Soon, however, the right head began to gain over the left which grew smaller, in fact, atrophied. Three months after hatching Audeville says that it was hardly visible. The fish (right head), when twenty months old (at the time of the writing of his article), no longer showed as a double-head. "There now remains a little above and slightly behind the left eye, almost at the point where the two heads were joined, only a little fleshy 'mamelon,' about 2 mm. in diameter and height, on which with the naked eye one can distinguish no trace of any organ." During the first months, probably by reason of two mouths doing the feeding, the monster grew faster than the average of the others of the same hatching. Presently, however, as the left head grew smaller, the fish lost this gain and at the age of twenty months was slightly smaller than the average. It was then, however, a troutlet 170 mm. (6.7 in.) long, and entirely able to maintain its equilibrium. In fact, says our author, there was at first glance nothing to distinguish it from others of the same species.

So far as I know, there is no account (other than in Mr. Townsend's letters to me) of the rearing beyond the hatching stage of a two-headed monster. This and the extraordinary condition of his fish at the age and size noted have made it well worth while giving the history of this specimen. However, as will be shown in another paper later, the only authenticated records of adult twin salmonids, and indeed the largest twin teleosts, are of those Siamese-twin forms in which the fishes are united laterally or are joined ventrally in the belly region. Of such, there are figures extant of fishes 5 and 6 inches in length, and accounts of specimens measuring 8 and 13.2 inches.

There are now to be presented three poorly authenticated accounts of adult double-headed fishes. Jonathan Couch in his 'History of the

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[1] 'Un Cas Singulier de Teratologie sur un Salmonide Monstreux.' Bulletin Société Acclimatation France. 1888, (4) V, pp. 990–993.

Fishes of the British Islands' (London, 1869, IV, p. 239), in speaking of malformed fishes, says that "Among the casual malformations, a trout was caught in Cornwall which had a second or smaller head, which appeared projecting from this natural part." However, Couch does not say that he had seen this, but seems rather to speak from hearsay. Another and even less authentic account is from Frank Buckland, who says that he "once read an account of a double-headed catfish (*Anarrichas lupus*) having been caught in the North Sea" ('Logbook of a Fisherman and Zoologist,' London, 1883, p. 151).

Of two-headed sharks there are quite a few records, only, however, of very young forms and generally of embryos still attached to the yolk-sac. These have been obtained by opening the mother, or have been extruded by her when caught or when hurt. However, there are on record the figure and description of what purports to be an adult or at least a fairly large two-headed shark. This, the oldest known record of a bicephalous fish, is found in the 'Monstrorum Historia,' one of the components of the encyclopedic 'Historiæ Omnium Animalium' of the distinguished Ulysses Aldrovandi. This huge folio, published after Aldrovandi's death by his loyal pupil, Bartholomæus Ambrosinus, bears imprint, "Bononiæ, 1642."

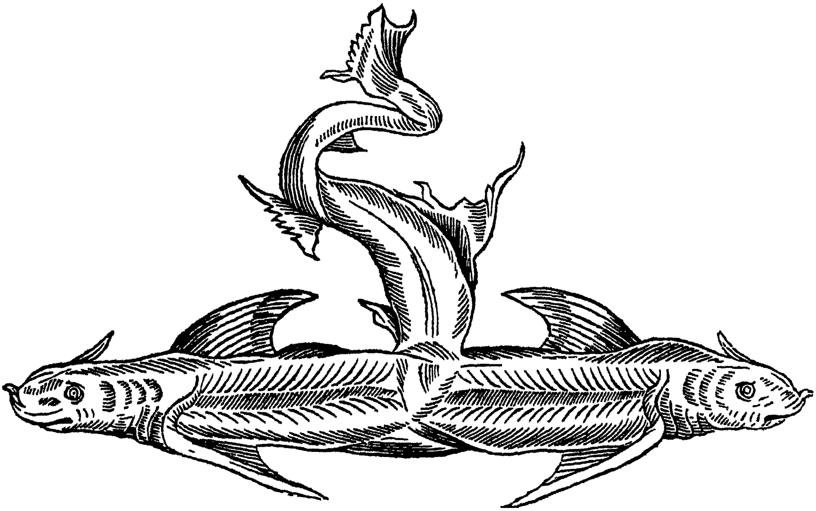

Fig. 3. A two-headed shark "from the River Nile," the oldest known figure of a bicephalous fish. After Aldrovandi, 1642.

On page 428 is the figure of this fish, which is reproduced herein as No. 3. It is said to have been taken in the River Nile near the town of

Latislana, and in size is said to have about equalled a crocodile. Now there are several criticisms to be made of this account. In the first place, there are no sharks known in the Nile, not even in the delta, for the tides in the eastern Mediterranean are so low (practically non-existent) that even the delta region has no brackish water. What the town of Latislana was is not known. Lippincott's 'Gazetteer' (1902 ed.) says that there is a town of that name near Udine, Italy. Furthermore, although the size of the crocodile is not stated, it is probable that a fish of at least two feet was indicated. There may have been such a large double-headed shark, but there is in the literature no other reference to such. Probably Aldrovandi or Ambrosinus had a double-headed embryo or just hatched young shark, which served as a basis for this account, and his artist did the rest. Or possibly his account is merely a bit of folk lore. At any rate, the figure is reproduced herein because of its historical interest.

THE CAUSE OF DOUBLE MONSTROSITIES IN FISHES

A variety of causes have been alleged in explanation of the origin of such monstrous fish as have been described above. No attempt will be made here to discuss these, and only brief mention of the chief ones will be made. At the close of this section reference will be given to a book in which the various theories are discussed.

Stephen Ludwig Jacobi[1] seems to have been the first professional breeder of trout and the first to note two-headed monstrous fish embryos. Jacobi described various kinds of these double monsters from two-headed to Siamese-twin forms, noted that such always die at the end of four or five weeks when the yolk is absorbed, and gave it as his opinion that "double fish have been generated when two spermatic animalcules have slipped into the egg." Further on he alleged that double fish and all monstrous productions result "when an egg is fructuated by more than one spermatic animalcule."

Under the heading "Causation," Gemmill in the great work previously referred to says: "There is strong reason for believing that the occurrence of double monstrosity is due in the main not to environmental factors but to conditions which are inherent in the fertilized germ cell." He recognizes that twin production has been brought about experimentally in many cases in invertebrate ova and in some holoblastic vertebrate eggs by separation of individual cells or masses of cells in early

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[1] Hannoverisches Magazine, 1763, No. 23; idem, 1765, No. 62 (both in German); English translation in Philosophical Magazine, 1890, XXXIV, pp. 324–333; also in Yarrell's 'History of British Fishes,' 1841, II, pp. 87–96.

stages of segmentation. He concludes, however, that such would be difficult to effect in meroblastic fish ova where the early cells are cut out of a syncytium. Still he notes that such experimental results have been brought about. And finally he says of polyembryony: "The view has often been suggested that the blastoderm may be looked upon as a stock, able to give rise vegetatively so to speak to more than one embryo." Then he concludes: "More probably, however, in animals, twinning, double and multiple monstrosity, and polyembryony provide instances in which a common 'potentiality' has become realized, and beyond that are not necessarily connected by any nexus of a direct or phylogenetic character."

C. R. Stockard[1] in an extensive paper, in which he summed up his long years of experimental work, declares that double monsters may be produced by developmental arrests by lowering the temperature or by reducing the oxygen supply. He notes that the notches around the edges of some plants have the power to give rise to buds and concludes that: "At a certain place along the germ-ring in the fish's egg a peculiarly rapid cell multiplication begins and the embryonic shield with the axis of the embryo buds away from this place." There is evidence then that more than one such place may be capable of forming the axis of an embryo. Probably there are a number of such potential points, but when one point has begun to proliferate cells, the others are normally inhibited. "The origin of two embryonic axes or growing points on the germ-ring of the fish probably results from a rather mild or slight reduction in the normal developmental rate at the time of gastrulation or embryonic-shield formation." And this may be brought about by lowering the temperature or decreasing the oxygen supply. Certain eggs after relief from low temperatures

> resume their cleavage processes, form a typical blastoderm and begin the formation of a germ-ring, which indicates the commencement of gastrulation, but just here the degree of energy necessary for normal developmental processes is insufficient and a single embryonic bud is not formed with that normal rate of growth which suppresses the appearance of other embryonic buds. Therefore, instead of the one point proliferating at a disproportionate rate to form the embryonic shield, two such points are established with more or less equal rates of proliferation, both of which may be somewhat less active than the single one should be. The formation of two embryonic shields, or the initiation of two points of rapid gastrulation away from which will grow the axes of the embryos, is in fact the initial or primary step in double formations.

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[1] 'Developmental Rate and Structural Expression: an Experimental Study of Twins, "Double Monsters" and Single Deformities, and the Interaction among Embryonic Organs during their Origin and Development.' American Journal of Anatomy, 1921, XXVIII, pp. 117, 163–166, 173–181, 255–257.

Then follows a recital of the experiments and descriptions of the monsters produced. However, Stockard notes that he got but relatively few monsters while he was working with the eggs of *Fundulus heteroclitus*, a form little given to producing monsters.

Noting that cell proliferation, which is fundamental for the production of embryos, is a great oxygen-consuming process, Stockard carried on experiments in which the eggs were allowed to clump together with a relative reduction of the amount of oxygen available for each egg, or they were placed in water from which the oxygen had been driven off by boiling. The results were directly comparable with those noted above.

Stockard experimented with the very hardy eggs of *Fundulus*, but he recognizes that double-monster formation is more common in salmonid eggs. This is probably due, in part at least, to the crowding of eggs in hatcheries and the resulting deficient aëration, but for all this there seems to be in salmonid eggs some inherent tendency to form monsters. Here is Stockard's own brief summary:

> By an interruption of development [by lowering the temperature or reducing the oxygen supply] during late cleavage stages, a considerable percentage of twins and double individuals may be produced. When the eggs of the sea-minnow, *Fundulus heteroclitus*, are subjected to temperatures of 5° or 6° C. during cleavage stages, development is almost stopped. On returning such eggs to a summer temperature, after several days' sojourn in the refrigerator, there will follow a high mortality, but many specimens will resume development producing a significant percentage of twins and a number of variously deformed conditions along with a good proportion of normally formed young fish.
>
> Arresting or stopping development of the same eggs during the same developmental stages by diminishing the available supply of oxygen will be followed by closely similar results.
>
> The eggs of the trout are naturally much more inclined to develop into double individuals than are those of *Fundulus*. When the oxygen supply during early development is not abundant, a great many twin and double trout specimens are frequently found to occur.

The whole subject of the nature, scope, and causation of twin formation has been admirably treated by H. H. Newman in his valuable book.[1] To this and especially to chapters IV and V, dealing with the various theories advanced to explain twin formation in fishes, the interested reader is referred.

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[1] 'The Physiology of Twinning.' Chicago, 1923, 230 pp., 71 text-figs.

AMERICAN MUSEUM NOVITATES

Number 370
Published by
The American Museum of Natural History
New York City
Sept. 6, 1929

59.84, 2 P (96)

BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. X[1]

ON *PTERODROMA COOKII* AND ITS ALLIES

BY ROBERT CUSHMAN MURPHY

In a recent study of *Puffinus assimilis* and its allies (1927, Amer. Mus. Novit., No. 276), I have endeavored to show that these small shearwaters are readily distinguishable as two species, differing in color characters as well as in zoogeographic distribution, and each represented by several subspecies. It now appears that the small Pacific petrels of the genus *Pterodroma* or "*Cookilaria*" present interrelationships of a curiously parallel type. The birds of this group were originally described under a variety of specific names, but in subsequent treatment they have either been "lumped" under one species, as by Mathews (1912, 'Birds Austral.,' II, p. 168), or else interspersed among other petrels, many of which are not closely related to the natural aggregation that forms the subject of this paper. Examples of the latter type of systematic treatment are those of Godman (1908, 1909, 'Monogr. Petrels,' parts III and IV, pp. 209, 212, 214, 243, 245, 247, 250, 252) and Mathews (1927, 'Syst. Avium Australasianarum,' pp. 120, 122, 123). Mathews even goes so far as to place one form (*Pterodroma brevipes*) in a different genus from the others, and to group the remainder in a specific and subspecific arrangement which, it seems to me, does not accord with the criteria of relationship.

For the preparation of this revision I have made use of large series of petrels obtained during the Whitney South Sea Expedition and the Brewster-Sanford South American Expedition, as well as of other specimens in the collections of The American Museum of Natural History and of similar institutions in the United States and Europe.

The oldest names applicable to the two species which seem to include all the forms under consideration are *Pterodroma cookii* (Gray) and *Pterodroma leucoptera* (Gould). Representatives of these may be distinguished as follows:

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[1] Previous papers in this series comprise American Museum Novitates, Nos. 115, 124, 149, 322, 337, 350, 356, 364, and 365

1. Crown, nape, sides of neck and breast, concolor with back, and close to the neutral gray series of Ridgway's 'Color Standards.' . .*Pterodroma cookii.*
2. Crown, nape, sides of neck and breast, much darker than back, forming a sharp contrast, and mainly sooty black *Pterodroma leucoptera.*

Examples of *P. cookii* always have more or less white on the inner vanes of the primaries; in *leucoptera* the condition is more variable. Moreover, the races of the latter species are mostly smaller, with relatively longer tails. A careful study of coloration and proportions, however, shows that the simplest and most certain way to distinguish the two species is by means of the invariable characteristics noted in the above key. In other respects, the races of both exhibit a certain parallelism in the nature of their variations.

In the following systematic section, only essential and inclusive references are cited.

Measurements of the specimens referred to in the text are published for convenience in a single table on p. 17.

Pterodroma cookii cookii (Gray)

Procellaria cookii GRAY, 1843, in Dieffenbach's 'Travels in New Zealand,' II. p. 199 (New Zealand).

Œstrelata cooki, SALVIN, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 417; GODMAN, 1909, 'Monogr. Petrels,' part IV, p. 247, Pl. LXXI.

Pterodroma cookii cookii MATHEWS, 1912, 'Birds Austral.,' II, p. 166, Pl. LXXXVII.

ADULTS (sexes alike).—Forehead, mainly white, but with a freckling of gray-centered feathers from the median base of the culmen, the gradual transition from white to gray plumage taking place on the anterior part of the crown, in the lores, and along the cheeks and sides of neck, which have a somewhat scalloped effect; crown, nape, interscapulars, lower back, upper tail-coverts, sides of neck, and sides of breast, gray (slightly lighter and more slaty than the neutral gray of Ridgway), the feathers of all these parts more or less margined with white in fresh plumage, most persistently so on the anterior part of the crown and the sides of neck and breast; (prolonged wear exposes the darker subterminal parts of the feathers, causing the crown and back to appear somewhat spotted with dark neutral gray and to show the blackish streaks of the feather shafts); a large, roughly triangular, blackish-brown patch on the rump; a narrow white infraorbital line, not easily discernible in all specimens, and beneath this a conspicuous broader stripe of dark neutral gray or blackish, which loops around the anterior canthus of the eye and extends caudad over the ear-coverts, widening as it blends with the gray feathers along the side of the neck; the boundary between gray dorsal, and white ventral, plumage more or less mottled through the intermingling of the colors along the cheeks and sides of neck and breast, some specimens showing also a faint dusting of gray along the white flanks; wings, blackish brown (3), with horny brown quill shafts, becoming lighter basally; the greater coverts and secondary quills contrast with the remainder of the wing in that they have a distinct neutral gray bloom and are externally and narrowly margined with white; inner vanes of remiges largely white, the sharply-marked white areas on the primaries extending as a pointed wedge from the base throughout about three-quarters of the length of each quill; central rectrices, largely neutral gray, terminally tinged with blackish brown; lateral rectrices, generally comprising the four outer pairs, somewhat variable, but as a rule white, heavily speckled with light neutral gray; inner webs of these quills sometimes pure white, sometimes pale gray, and sometimes showing an intermediate speckling; outer webs, usually either solidly gray or heavily speckled; entire ventral surface of body, from chin to under tail-coverts, white; lining of wing, white, except along its anterior edge, where a mixture of blackish brown, white, and neutral gray feathers with white emarginations, produces a narrow, irregularly mottled border.

Considerable variability is noteworthy in the amount of white emargination on the dorsal plumage, the conspicuousness and extent of the blackish infraorbital patch, the extent of white feathering above the eye, which sometimes gives the appearance of a supraorbital stripe, the general hue of the gray parts of the plumage (due mainly to wear), the conspicuousness of the rump patch, which is in some cases only slightly evident, and the wide range in markings on the outer quills of the tail.

Two specimens, Mokohinou Islets, fifteen miles northwest of Great Barrier Island, east coast of North Island, New Zealand, January 3, 1926; a good series from between lat. 34° S., long. 176° W., and lat. 39° S., long. 179° W., December, 1925; others from lat. 47° S., long. 175° E., February, 1926.

The pelagic localities lie east of both islands of New Zealand, from a point southeast of the Kermadecs southward to waters west of Bounty Island. The Mokohinou birds may be regarded as topotypes and the others agree with them. Only one specimen, a female taken at sea on December 10, appeared to be in breeding condition.

All forms of *Pterodroma cookii* and *leucoptera* seem to have black bills and, of course, brown irides. The only differences in flesh colors are those of the tarsi and feet. In our specimens of *P. c. cookii*, these are noted as "tarsus, upper third of foot, and inner toes, blue; remainder black."

Pterodroma cookii axillaris (Salvin)

Œstrelata axillaris Salvin, 1893, Bull. Brit. Orn. Club, I, p. xxxiii (Rangatira, or Southeast, Island, Chatham Islands); 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 418, Pl. vii; Godman, 1909, 'Monogr. Petrels,' part IV, p. 252, Pl. lxxii.

Subspecific Characters.—Of smaller size than typical *cookii*, except in length of tail, and with a notably shorter bill; white of forehead more restricted, dark feathers being thickly interspersed medially from the base of the bill, and through the loral region; inner wing and a wide external border, in ventral aspect, as well as axillaries, blackish; dark rump-patch nearly obsolete.

Seven specimens in the American Museum collection, including several of the type series obtained by Hawkins; others examined in the Frankfort and British Museums. The only dated specimens were taken during May, 1892.

The Whitney Expedition visited Rangatira and the other islands of the Chatham Group during March, 1926. Since this petrel was not found, it seems likely that the nesting season had not commenced.

One statement in Salvin's excellent description is not borne out by my observations on a dozen or more skins, namely, that the dorsal surface in this race is "paler" than that of the typical *cookii*. However, the same author appears to have amended this in the 'Catalogue.' Godman states that the crown is slightly darker than the back, but this difference, when detectable, seems to be due to uneven plumage wear. It is also sometimes evident in the typical race, but there is certainly no approach to the definite contrast between pileum and back which is characteristic of all forms of *Pterodroma leucoptera*.

The maximum bill length in *axillaris* hardly attains the minimum measurement in a long series of typical *cookii*.

Pterodroma cookii nigripennis (Rothschild)

Œstrelata nigripennis Rothschild, 1893, Bull. Brit. Orn. Club, I, p. lvii (Kermadec Islands); Salvin, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 409; Godman, 1908, 'Monogr. Petrels,' part III, p. 214, Pl. lix.

Subspecific Characters.—Of intermediate size between the two preceding races, but with a longer tail than either, the minimum range of tail-length equalling or exceeding the maxima for typical *cookii* and *axillaris*; white area on inner vanes of primaries reduced, appearing only basally on the outermost quill, and on the proximal half of the second; gray area at sides of neck and breast more extensive than in other races of *cookii*, having a tendency to join across the breast and to extend, in the form of vermiculate bars, toward the throat and along the whole length of the flanks; feathering in front of and below the eye usually more densely black than in other forms of the species.

An excellent series of specimens from the Kermadec Islands (Herald and Macauley Islands, November, 1925; also numerous older examples from Raoul, or Sunday, Curtis, Meyer, and Macauley Islands, some of them dated February, 1895); three specimens from Bass Rock, about fifty miles east by south from Rapa Island, Austral Group, February 27, 1922; and numerous Kermadec examples examined in the museums at Berlin and Tring.

The specimens from Bass Rock are indistinguishable from Kermadec topotypes. Some of the Herald Island birds were taken from the nest.

Beck's notes made at Herald, Curtis, and Macauley Islands, between November 13 and 20, 1925, state that many of these petrels were seen entering or emerging from their burrows during the daytime. Some of the holes contained well-developed young, but in certain adults the condition of the gonads seemed to indicate that the eggs had not long been laid. The claws of some of the breeding birds were worn down from the labor of burrowing.

Beck records the flesh colors as "tarsus and upper part of foot, flesh color; remainder black, including the whole length of the outer toe."

Pterodroma cookii orientalis, new subspecies

?*Œstrelata defilippiana,* Sharpe, 1881, Proc. Zoöl. Soc. Lond., p. 11 (San Ambrosio Island); ? Godman, 1909, 'Monogr. Petrels,' part IV, p. 245 (part).

Subspecific Characters.—Very similar to *Pterodroma cookii cookii,* but averaging larger, and with a more pronounced appearance of scalation on the dorsal surface, due to broader and more general white emargination of the feathers.

Type.—No. 364, Brewster-Sanford Coll., Amer. Mus. Nat. Hist.; ♂ ad.; 200 miles west of Callao, Peru; June 9, 1913; R. H. Beck.

Range.—Off the west coast of South America, in the warm ocean waters to westward of the upwelling zone of the Humboldt Current. Specimens from 50 to 400 miles off the coasts of Peru and Chile, between 12° and 34° south latitude. Breeding ground not known.

Twenty specimens from the following points in the eastern South Pacific: 200 miles west of Callao, Peru, June 6–10, 1913; 50–80 miles west of Ancon, Peru, June 12–16; within five miles of Masatierra Island, Juan Fernandez Group, Chile, December 19, 1913.

These specimens are apparently the first of an indubitably *cookii* type to be recognized from the eastern South Pacific. If they had been collected near the New Zealand region, it would take considerable temerity to attempt to separate them from the typical form. However, our twenty specimens show that the average dimensions are greater than those revealed in a large series of *P. c. cookii,* and that the maximum ranges, particularly in the length of the wing, are decidedly larger. Moreover, in *orientalis* the scalation of the back, and particularly that of the crown, is very pronounced, the broadly white-edged feathers extending well toward the nape.

When we consider that the petrels of this group have a more restricted individual and racial range than was formerly believed, no choice is left but to give the bird of the South American coast a distinct systematic ranking.

P. c. orientalis is the closest to the typical form of any of the races of *cookii* recognized in this study. Beyond a doubt, the bird has been collected before and has, not unnaturally, been confused with *defilippiana*, the resident race of Juan Fernandez. To an ornithologist with only one or two examples of each at his disposal, such confusion might be almost unavoidable. When, however, the two are represented by good series of specimens collected throughout the same oceanic region, and reinforced by breeding examples of *defilippiana* taken from their nests, such doubts are immediately resolved. *P. c. orientalis* has a slender and smooth black bill of exactly the same type as that of *cookii* from New Zealand. *P. c. defilippiana*, on the other hand, has a remarkably deep, heavy bill, in which the plates of the latericorn, unguis, etc., have a strong tendency to be rugose, and even to develop a laminated aspect, so that they are more or less marked with fine horny lines. The bills of fledgling young, as well as adults, of *defilippiana*, have, as a matter of fact, this characteristic appearance, and even in such early stages they are pronouncedly deeper and heavier than the bills of adult specimens of *P. c. cookii* and *P. c. orientalis*.

Of the breeding ground of *P. c. orientalis* we know nothing, but it may be pointed out that the islands of San Felix and San Ambrosio lie about midway in its range. The implication may even now be capable of solution by examination of specimens in the British Museum, for on July 21, 1879, Coppinger collected at San Ambrosio a small petrel which has been recorded by Sharpe as *defilippiana*.

With regard to possible previous confusion of these forms, we may note, furthermore, the following remarks by Godman ('Monogr. Petrels,' p. 245): "*Œ. defilippiana* is very closely allied to . . . *Œ. cooki*, and may yet prove to be identical with it, in spite of the difference of habitat. . . . I have examined several specimens . . . , and find them difficult to separate."

To this I can only say that the differences are absolutely clean-cut, and would, I believe, be obvious to any ornithologist who had once seen abundant material. In short, the bill characters of the two are so distinctive that once recognized they could never again be mistaken in either nestling or adult birds. The real systematic problem is not, indeed, to find criteria which distinguish *orientalis* from *defilippiana*, but rather those which separate *orientalis* from typical *cookii*. In the latter case we are forced to the use of average measurements, and the relatively slight differences in pattern noted above.

The colors of the feet in *orientalis* are apparently exactly as in typical *cookii* of the New Zealand region. All our specimens appeared to be non-breeding birds, which is natural since most of them were obtained during the heart of the southern winter.

Pterodroma cookii defilippiana (Giglioli and Salvadori)

Æstrelata defilippiana Giglioli and Salvadori, 1869, Ibis, p. 63 (off northern Chile).

Œstrelata defilippiana Salvin, 1876, Rowley's 'Ornith. Misc.,' I, p. 255, plate; Salvin, 1896, 'Cat. Birds Brit. Mus.,' XXV, p. 417; Godman, 1909, 'Monogr. Petrels,' part IV, p. 245, Pl. lxx.

Pterodroma cookii defilippiana, Lönnberg, 1921, 'Nat. Hist. Juan Fernandez and Easter Island,' III, Zool., part 1, p. 14.

Subspecific Characters.—Distinguishable from all other forms of *Pterodroma cookii* by the great depth of the bill and the length of the tail; in the latter character it is approached only by *P. c. nigripennis.*

Adults and young from Masatierra Island, Juan Fernandez, January 20, 1914. Other adults taken over the ocean within about five miles of Masatierra, December 30, 1913, January 3–22, 1914. Pelagic specimens as follows: 100 miles west of Valparaiso, December 3; lat. 33° S., long. 74° W. (between Valparaiso and Juan Fernandez), December 5; 200 miles west of Callao, June 6–9, 1913; 50–80 miles west of Ancon, Peru, June 12–16.

The pelagic range of *P. c. defilippiana* is thus extended far to the northward of previous records. Many of our specimens were collected in company with examples of *P. c. orientalis* but, as stated above, the two are easily separable.

Beck found these petrels nesting under ledges of rock on the main island of Masatierra, and also saw evidences of their occupation at the neighboring islet of Santa Clara, where, however, he obtained none. All of the adults collected during December and January had small gonads, showing that the egg-laying period had long passed by. Lönnberg reports eggs from Santa Clara collected on August 9, 1917.

The depth of the bill of *defilippiana,* in front of the nostrils, ranges from 8–8.5 mm., and the width of the maxilla at the base from 11–12 mm. In *P. c. orientalis* the respective measurements are: depth 6–6.8, width of maxilla 9.5 mm. Salvin's plate of this petrel, in Rowley's 'Ornithological Miscellany,' is much better than the later figure in Godman's 'Monograph,' in its depiction of the heavy bill. The color of the feet seems to be as in typical *cookii,* with the tarsi and upper third of the two inner toes light blue.

Although Giglioli and Salvadori state that examples of *defilippiana* followed their ship to a point "not far from the Peruvian coast," the figures for their position show that they refer to a locality several hundred miles from any part of the continental shore. It is altogether probable that the oceanic ranges of both *P. c. defilippiana* and *P. c. orientalis* lie exclusively in the subtropical part of the Pacific Ocean, well beyond the cool zone of the Humboldt Current. Neither species has been encountered within about fifty miles of the coast, nor is it likely that they can be found on any short boat excursions from land. The cool waters that fringe the west coast of South America, with the lowest temperatures within a few miles of the shore, are inhabited mainly by Tubinares of quite a different type, including such south temperate and subantarctic genera as *Oceanites*, *Macronectes*, *Priocella*, and *Puffinus griseus*.

Pterodroma leucoptera leucoptera (Gould)

Procellaria leucoptera GOULD, 1844, Ann. Mag. Nat. Hist., XIII, p. 364 (Cabbage Tree Island, Port Stephens, New South Wales); 1844, Proc. Zoöl. Soc. Lond., p. 57.

Procellaria cookii GOULD, 1848, 'Birds Austral.,' VII, Pl. LI.

Œstrelata leucoptera SALVIN, 1896, 'Cat. Birds Brit. Mus.,' p. 416; GODMAN, 1909, 'Mongr. Petrels,' part IV, p. 243, Pl. LXIX.

Pterodroma cookii leucoptera MATHEWS, 1912, 'Birds Austral.,' II, p. 171, Pl. LXXXVIII.

ADULTS (sexes alike).—Forehead and greater part of lores, white, but freckled with a few black-centered feathers, especially along the mid-line from the bill to the anterior border of the crown, where the transition to dark plumage is abrupt; circumorbital region, except for a narrow white infraorbital stripe and a variable amount of speckling in front of the eye, sooty black; crown, and a definite mantle which includes the nape, anterior part of the interscapular region, sides of neck, and a large and conspicuous patch at the side of the breast, sooty black; back and upper tail-coverts, close to light neutral gray, each feather with a faintly discernible dark shaft streak and, in fresh plumage, a narrow white terminal margin; a large, more or less triangular sooty black patch on the rump; wings, blackish brown (3), with a pointed, wedge-like white or mottled white area on the inner vanes of the quills, usually less definite and less extensive than in *P. cookii cookii;* greater coverts and secondary quills, neutral gray, externally margined with white; tail quills, neutral gray, the central pairs with sooty terminations, the outer pairs mottled gray and white, much as in *P. cookii cookii;* entire ventral surface, from chin to lower tail-coverts, white; wing lining, white, with the anterior margin mottled as in *P. cookii cookii.*

Two specimens, both females, taken during the Whitney South Sea Expedition. One was shot at sea, November 7, 1925, in lat. 27° S., long. 178° E. (northwest of the Kermadec Islands); the other was "blown ashore, starved," on the beach at Efate Island, New Hebrides, June 4, 1926.

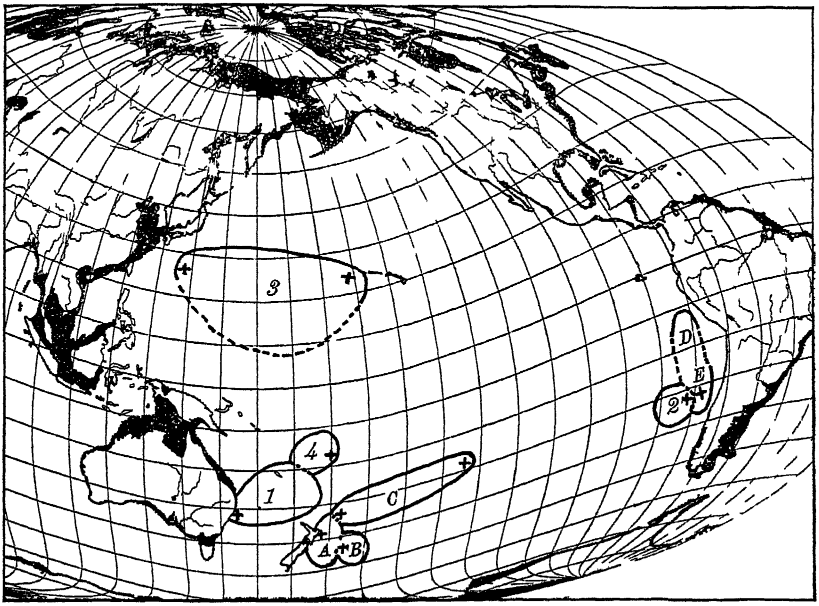

Fig 1 Ranges of the races of two species of *Pterodroma* in the Pacific Ocean, based solely upon specimens examined during the preparation of this paper Crosses mark the position of breeding grounds

A *Pterodroma cookii cookii* (New Zealand) B *P c axillaris* (Chatham Islands) C *P c nigripennis* (Kermadec Islands and Bass Rocks or Maretiri) D *P c orientalis* (breeding ground unknown) E *P c defilippiana* (Masatierra Island Juan Fernandez)

1 *P leucoptera leucoptera* (east coast of Australia and neighboring tropical and subtropical Pacific) 2, *P l masafueræ* (Masafuera Island Juan Fernandez) 3 *P l hypoleuca* (tropical and subtropical Pacific in the northern hemisphere) 4 *P l brevipe* (Melanesian groups)

The oceanic ranges of all the forms are doubtless more extensive than indicated and characterized by pronounced overlapping The actual breeding areas are probably everywhere exclusive as at the Juan Fernandez Islands

These two are identical with Gould's type specimen from Port Stephens, which has been kindly lent to me by the Academy of Natural Sciences, of Philadelphia, through the courtesy of Dr. Witmer Stone. In both pattern and measurements the type differs only minutely from our two recently collected birds. However, the oil of decades has soaked into the dorsal plumage of the old specimen, turning the back dark, while the hue of the head and nape has browned with age. For these reasons, the distinction in color between head and back, which is characteristic of the species, is more or less obscured.

Most of the published descriptions of the typical race of *P. leucoptera* have been based upon the same group of three or more aged and greasy specimens. Mathews has already called attention to this fact, and has, on p. 172 of his monographic work, amended the earlier descriptions. His only statement, with which I cannot agree, points out alleged differences in appearance between the sexes.

Gould's plate is in no way diagnostic; it might represent some form of *Pterodroma cookii* even better than the bird he had named *leucoptera*. It is curious, moreover, that although Godman and Mathews give good textual descriptions of this petrel, their plates (both said to be based upon paratypes) resemble each other very little. Neither one is a good illustration of the bird, for both fail to reveal many striking features, such as the contrast in color between crown and back, the extent of the black feathering at the side of the neck, the white emargination of fresh plumage on back and wings, the mottling on the outer rectrices, etc. Godman's plate is the better of the two, that of Mathews showing practically none of the characters of a recently collected specimen.

Beck's notes on the label of our specimen taken at sea near the Kermadec Islands give the length of the dead bird in the flesh as 310 mm., and the expanse of the outstretched wings as 730 mm. The ovaries were slightly enlarged. The color of the tarsus and upper third of the foot was whitish or flesh, the remainder black.

The comments by Gould, Godman, and others as to where this petrel has been, or has not been, observed at sea during various voyages may all be discounted. In view of the confused identifications of various races of *P. leucoptera* and *P. cookii*, when represented by specimens in the hand, it is absolutely certain that they have not been correctly distinguished in life. Thus Salvadori states that *leucoptera* was not seen during the cruise of the 'Magenta,' whereas we now know that this vessel spent much time within the common oceanic range of at least three petrels between which that author could hardly have discriminated in the field, namely, *P. leucoptera masafueræ*, *P. cookii orientalis*, and *P. cookii defilippiana*. Never has the fundamental importance of systematic work been more apparent.

Pterodroma leucoptera masafueræ Lönnberg

Pterodroma (Æstrelata) cookii masafueræ LONNBERG, 1921, 'Nat. Hist. Juan Fernandez and Easter Island, III,' Zool., part 1, p. 14 (Masafuera Island, Juan Fernandez Group, Chile).

SUBSPECIFIC CHARACTERS.—Distinguishable from *Pterodroma leucoptera leucoptera* as follows: size slightly smaller, excepting the tail, which is apparently longer than in the typical race; crown less blackish, and the dark coloration more restricted, terminating rather sharply at the nape, whereas in typical *leucoptera* it extends caudad into the scapular region and very definitely into the patch at the sides of the breast (in *masafueræ* the latter areas are distinctly gray rather than sooty black); white feathering extending much higher on the forehead, usually terminating in a line drawn through the center of the eyes, some specimens having practically clear white foreheads (in the typical form the extreme breadth of the whitish forehead, measured from the base of the culminicorn, is about 12 or 13 mm; in *masafueræ* it averages about 23 mm.); the tarsi are grayish black, instead of flesh-color.

Ninety specimens, collected by R. H. Beck during the course of the Brewster-Sanford South American Expedition, as follows: twenty miles north of Masafuera Island, December 20 and 22, 1913; two to eight miles from the coast of Masatierra Island, December 19, 30, 1913, January 3–29, February 9, 1914.

Beck was unable to land at Masafuera, owing to rough seas; consequently he obtained no specimens at their nests. The petrels of this species breed only at Masafuera, whereas *P. cookii defilippiana* occupies the main island of Juan Fernandez (Masatierra), and the neighboring islet of Santa Clara, in an equally exclusive manner. The interesting circumstances are described by Lönnberg from the observations and collections of Backstrom. Both species mingle indiscriminately in the waters around the islands, while wandering examples of *P. cookii orientalis* likewise enter the same region. In view of the distinctive characters of *P. leucoptera masafueræ*, it seems extraordinary that the bird remained unnoted in literature until Lönnberg's description appeared in 1921.

Most of our specimens collected during January and February had reduced gonads; among those taken in December, there was evidence that the breeding season had not long passed, while bare abdomens indicated that some were still either incubating the egg or brooding young.

There is considerable variation in the plumage, which seems to be correlated with moult and wear. Thus, December specimens have very gray backs, scaled with white feather edgings. The line of demarcation between the back and the darker gray of crown and nape is very sharp. Through the effect of abrasion the white margins on the back disappear rapidly, so that they show scarcely at all among birds collected during February or late January. The back becomes progressively spotted with black, owing to the appearance at the surface of the dark feather-shafts as the distal margins of the feathers wear away; for the same reason the line of demarcation between nape and back becomes less distinct. Variation is also great in the relative whiteness of the forehead, the speckled area being more extensive in some specimens than in others. Again, the tail quills also vary widely, those of some birds being clear gray even to the outermost, while in others the outer pairs are heavily speckled. The central rectrices are practically black distally.

A single aberrant specimen (Brewster-Sanford Coll., No. 1941, ♂) requires special notice. This bird, which was taken within five miles of Masatierra on February 9, 1914, is much smaller in every dimension than any other in the large series, the bill, for example, being 3 mm. shorter than the minimum length among the others. Its measurements, which are not included in the table on p 17, are as follows: wing, 210; tail, 95; culmen, 21; tarsus, 27; middle toe with claw, 32 mm.

This specimen shows no evidence of being a young bird. Moreover, my experience with petrels convinces me that fledglings which have already taken to sea are not, as a rule, smaller in length of bill, wing, etc., than mature birds. Two explanatory hypotheses are admissible. The first, which is by no means impossible, is that the abnormally small specimen represents a distinct race of the species from some unknown breeding station. The second, and more likely, is that the bird is merely a dwarf of *P. leucoptera masafueræ*. Such phenomena are known, and I have already pointed out a similar case of an abnormally short-billed shearwater in a frequency-distribution graph of fifty adults of *Puffinus lherminieri dichrous* (1927, Amer. Mus. Novit.. No. 276, p. 11). Such a specimen would be troublesome to a systematist if it chanced to form one of only four or five skins. When, however, it is the only anomaly among ninety, it may be justifiably disregarded in subspecific diagnosis.

Pterodroma leucoptera hypoleuca (Salvin)

Œstrelata hypoleuca SALVIN, 1888, Ibis, p. 359 ("Krusenstern Island, North Pacific Ocean"); GODMAN, 1908, 'Monogr. Petrels,' part III, p. 212, Pl. LVIII.

Æstrelata hypoleuca STEJNEGER, 1893, Proc. U. S. Nat. Mus., XVI, p. 617.

Cookilaria hypoleuca MATHEWS, 1927, 'Syst. Avium Australasianarum,' p. 122.

SUBSPECIFIC CHARACTERS.—Differs from the preceding races of *P. leucoptera* in its larger size, which is most marked in the length of the tail, and in having no white on the primary quills; the wing lining, moreover, is mostly dark, except on its innermost feathering.

Eight specimens in the American Museum collection: three males, two females, Laysan Island, Hawaiian Group, September, 1895, April, 1903, January and February, 1913; three unsexed specimens, Bonin or Ogasawara Islands, January and February, 1910. Other specimens from Laysan examined in the Berlin Museum.

This form is strongly reminiscent of *P. leucoptera masafueræ*, with the white or white-edged feathers running well over the forehead, and, in some instances, covering most of the crown. It would, in fact, be difficult to distinguish certain specimens of the two forms were it not for the fact that *masafueræ* has conspicuous white areas on the inner vanes of the primaries, whereas in *hypoleuca* these quills are uniformly dark as in "*P. orquata*" (*P. leucoptera brevipes*) with which the original describer compared it. Both *hypoleuca* and *brevipes* clearly belong in the Formenkreis of *Pterodroma leucoptera.*

"Krusenstern Island," the type locality of Salvin's specimen, appears in Brigham's 'Index to the Islands of the Pacific' only as a synonym for Tikahau, of the Tuamotu Group, south of the equator. According to Godman and Mathews, the locality referred to is one of the Marshall Islands, in the eastern part of the present Japanese Mandate Territory. However, I can find no island in the Marshall Group to which the name Krusenstern has ever been applied. A better supposition, it seems to me, is that the type came from one of the islets which have been called "Krusenstern Reef," southwest of Laysan, in the Hawaiian Group. This islet of uncertain position has doubtless been visited by the Japanese feather collectors who once worked at Laysan, and through such hands the type skin may have reached Yokohama. The range of the subspecies probably covers a wide area in the tropical and subtropical North Pacific, for Laysan and Bonin specimens are indistinguishable.

Pterodroma leucoptera brevipes (Peale)

Procellaria brevipes PEALE, 1848, 'U. S. Expl. Exped.,' VIII, p. 294 ("Lat. 68° S., Long. 95° W.").

Procellaria torquata MACGILLIVRAY, 1860, Zoologist, XVIII, p. 7132.

Œstrelata leucoptera SALVIN, 1876, Ibis, p. 393 (footnote).

Œstrelata torquata SALVIN, 1891, Ibis, p. 411, Pl. IX; GODMAN, 1908, 'Monogr. Petrels,' part III, p. 209, Pl. LVII.

Æstrelata brevipes STEJNEGER, 1893, Proc. U. S. Nat. Mus., XVI, p. 619.

Pterodroma brevipes Mathews, 1927, 'Syst. Avium Australasianarum,' p. 120.

Subspecific Characters.—Smaller than any of the preceding races of *P. leucoptera*, except in length of tail, in which it equals or slightly exceeds the typical form; occurs in two phases, of which the gray is diagnostic; white-breasted examples are distinguishable from other subspecies by one or more of the following characters: primary quills entirely dark (as in the larger *P. l. hypoleuca*); white forehead very narrow (as in *P. l. leucoptera*); a tendency toward fine, dark gray peppering of the white ventral plumage, apparently always present at the sides of the breast, and extending in many specimens as a band across the breast and along the whole length of the flanks. In fact, the varying density and extent of this dark speckling produces every stage of intergradation between white-breasted and gray-breasted phases of the subspecies.

Twenty-seven specimens, as follows: one white-breasted, one intermediate, and five gray-breasted adults, taken at sea, thirty miles east of Meralav (Melepav or Star Peak) Island, Banks Group, New Hebrides, January 27–29, 1927; twenty adults and young, all of the white-breasted, or nearly white-breasted, phase, taken at the nests on Kandavu Island, Fiji Group, June, 1925. A male from the mountains of Viti Levu, Fiji Group, May, 1878, examined in the Berlin Museum.

Our Fijian adults had mud from their burrows upon the bills and feet, but no details about the capture can be found in Beck's notes. The young are mostly well advanced, and some of them have all but lost the down. According to the labels, the tarsi and upper part of the feet were flesh-colored in nestling birds, and blue in adults, the distal parts of webs and toes being black.

Mature specimens of this race in the white-breasted phase, and with a minimum amount of fine gray speckling at the sides of the breast, are almost counterparts of typical *leucoptera*. No doubt the two have often been confused, as they probably were by Salvin (1876) when he recorded "*Œstrelata leucoptera*" as a breeding bird of the Fiji Islands. The presence or absence of the white patch on the inner vanes of the primaries may, however, always serve to distinguish the two forms, besides which they are of slightly different proportions, *brevipes* having a smaller bill, tarsus, and foot. Moreover, the gray speckling referred to is never entirely absent from specimens of *brevipes*. Ordinarily it extends more or less across the breast, down the flanks, and onto the white under tail-coverts. Other specimens are far more heavily marked, the ultimate state being complete saturation of the ventral plumage, caudad from the throat, with dark pigment. The race should not properly be called dichromatic, because the extreme phases are connected by specimens exhibiting every intergrading stage from pure white to very dark gray.

Many of our specimens, especially the young birds, show on the head and neck the white filoplumes mentioned by Stejneger. Salvin (1891, p. 412) speaks of nestlings only a few days old, from Aneiteum, New Hebrides, as being "covered with black down." Our nestlings from Kandavu, are, as stated above, nearly full-grown, and the long mesoptyle down is plumbeous-gray on the dorsal surface and whitish on the ventral surface.

Salvin's plate of the wandering example of this petrel shot on the Welsh coast is not a good likeness of specimens before me, failing altogether to show the rich blackish-brown tone of the wings, sides of neck, nape, crown, and infraorbital region. Godman's plate is better, although the back is too dark and there is little indication of the invariable and characteristic fine gray speckling on the sides of the neck of white-breasted examples. Finally, the color of the legs is not correct for adult birds.

It is odd that the alleged type locality of Peale's "*Procellaria brevipes*," which is near Peter Island in the eastern South Pacific, south of the antarctic circle, has never been questioned. Peale's published remarks are as follows: "Two specimens were shot on the 21st day of March, in latitude 68° S., longitude 95° W. . . . The labels having been displaced after the specimens were sent home, the sex cannot be given with certainty now, but they are believed to be males." This comment, written some years after the reported capture of the specimens, is enough to throw some doubt on all of the data. The race is unquestionably equatorial in its normal distribution, even though a record made in the antarctic may be no more remarkable than the one made in the British Isles.

GENERAL REMARKS

The above notes are believed to cover all of the known forms of the two species except the "*Æstrelata longirostris*" of Stejneger, (1893, Proc. U. S. Nat. Mus., XVI, p. 618, Hondo, Japan). This I have not seen, but it is clearly a member of the *leucoptera* Formenkreis. In fact, hardly any item of the original description, including the length of the bill and of the nasal tubes, the white wedge on the inner webs of the primaries, the white sprinkling on the rectrices, and the clear white lining of the wing, would serve to distinguish it from the type skin of *Pterodroma leucoptera leucoptera*. The tail, however, seems a little too long, according to Stejneger's measurements.

A certain parallelism in the races of the species *cookii* and *leucoptera* has already been mentioned. Thus, the length of bill and tail varies in the two groups in much the same manner, although, as a whole, *cookii* is the longer-billed species, *leucoptera* the longer-tailed. *P. c. orientalis* bears about the same relationship to typical *cookii* that *P. l. masafueræ* does to typical *leucoptera*. *P. c. axillaris* is, in general appearance, a sort of analogue of *P. l. hypoleuca*, while *P. c. nigripennis* can be paired in a similar way with *P. l. brevipes*, both the latter forms having a tendency toward vermiculate or speckled markings not found in another race of either species. Throughout all of these superficial resemblances, however, the specific distinctions clearly hold.

As with the races of *Puffinus assimilis* and *Puffinus lherminieri*, those of the two species of petrels under discussion have a somewhat different general distribution. Thus, the known breeding grounds of all forms of *Pterodroma cookii* lie to southward of the tropic of Capricorn. In other words, the species is characteristic of the south temperate Pacific Ocean. *Pterodroma leucoptera*, on the other hand, is mainly a tropical or subtropical petrel. *P. leucoptera leucoptera* extends its breeding range only a little to the southward of the tropics on the Australian coast; *P. l. hypoleuca*, in like manner, penetrates into subtropical island groups of the northern hemisphere. *P. l. masafueræ* seems less true to type, for it nests at an island beyond latitude 33° S. The case may, however, be more apparent than real, for Masafuera lies in an essentially subtropical ocean. It is interesting, and doubtless significant, that of the two islands of Juan Fernandez, which lie nearly a hundred miles apart in an east-west line, the local race of *Pterodroma leucoptera* has occupied the offshore island, while the race of *Pterodroma cookii* is confined exclusively to the inshore island which is influenced more by the cool littoral waters of the Chilean coast.

All in all, the two species show striking resemblances in distribution, and even in the respective differences of their pattern and color, to the phenomena exhibited by the Formenkreise of *Puffinus assimilis* and *Puffinus lherminieri*.

Measurements of the Races of *Pterodroma cookii* and *Pterodroma leucoptera*

	NUMBER OF SPECIMENS MEASURED	WING			TAIL			EXPOSED CULMEN			TARSUS			MIDDLE TOE WITH CLAW		
		Min	Max	Aver	Min	Max	Aver	Min	Max	Aver	Min	Max	Aver	Min	Max	Aver
P cookii cookii	12	230	240	**235 2**	85	92	**89**	26 7	29	**28 1**	29	32	**31**	37	40	**38 5**
P " axillaris	10	211	223	**217 3**	88	94	**91**	23 5	26	**24 4**	29	31	**30 2**	36	38	**37**
P " nigripennis	13	224	233	**228**	95	101	**98**	23 5	25	**24 2**	29	31 5	**30**	35	39	**37**
P " orientalis	19	234	250	**239**	85	97	**91**	27 6	30	**29**	30	32	**31**	38	41	**40**
P " defilippiana	10	229	241	**235**	97	108	**102 1**	28 5	29	**29**	29	31	**30 2**	34	37	**35 5**
P leucoptera leucoptera	3	224	226	**225**	89	93	**91**	25	27	**25 7**	29	30	**29 7**	37	38	**37 3**
P. " masafuerae	10	216	230	**221**	97	105	**100**	24	26	**25**	27	30	**27 2**	34	37	**36 4**
P " hypoleuca	9	225	232	**228 2**	102	114	**110**	24 6	27	**26**	28 5	31	**29**	34	38	**36**
P " brevipes	13	207	226	**218**	91	99	**95**	22	26	**24 3**	26	28	**26 5**	32	35	**34**

AMERICAN MUSEUM NOVITATES

Number 371
Published by
The American Museum of Natural History
New York City
Sept. 26, 1929

59 57, 53D (729 5)

A NEW GENUS AND SPECIES OF DERBID FROM PORTO RICO

By H. L. Dozier[1]

As only a few Derbids have been recorded from the West Indies it is a pleasure to record here this interesting addition to the fauna of that region.

Dawnarioides, new genus

Closest allied to the genus *Dawnaria* (Distant, 1911, Ann. Mag. Nat. Hist., (8) VIII, p. 642).

Head (including eyes) distinctly narrower than the pronotum; vertex projecting beyond the eyes with median depression; frons long and narrow, enlarged at juncture with clypeus, the clypeus long and distinctly tricarinate; antennæ not abnormally developed and with the second joint of moderate length; pronotum very short, deeply and angularly emarginate posteriorly; tegmina long, gradually amplified from base for two-thirds of the length and then narrowed again, the veins mostly longitudinal, forking towards apex to form numerous apical cells; wings ample, about two-thirds as long as the tegmina, with a distinct flare along posterior margin at base; legs long and slender.

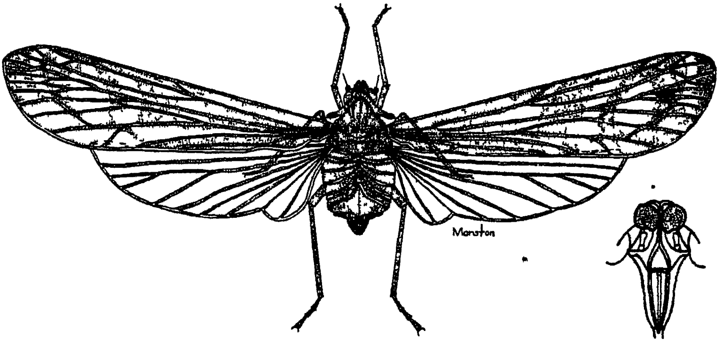

Fig. 1.—Adult female of *Dawnarioides musæ*, new species.

Genotype.—*Dawnarioides musæ*, new species.

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[1] Entomologist, Delaware Agricultural Experiment Station.

Dawnarioides musæ, new species

Body and legs pale testaceous, the last three abdominal segments marked with orange-red on dorsum, the ovipositor slightly fuscous. Abdomen short and broad, medianly ridged on dorsum. Tegmina distinctly longer than the wings, grayish hyaline with four whitish transverse fasciæ, the one nearest the apex being the most narrow.

Length, exclusive of tegmina, 2.25 mm.; with tegmina expanded, 11 mm.

Described from a large series of adults collected by the writer from the under surface of banana leaves, in a shaded nook near Comerio, Porto Rico, May 10, 1925.

Holotype female, allotype male, and two paratype males deposited in The American Museum of Natural History; three paratypes each deposited in the collections of the U. S. National Museum, Frederic Muir, and H. L. Dozier.

AMERICAN MUSEUM NOVITATES

Number 372
Published by
The American Museum of Natural History
New York City
Sept. 28, 1929

54.9,3 (74.9)

A CRYSTALLOGRAPHIC NOTE ON GREENOCKITE FROM WEST PATERSON, NEW JERSEY

By Herbert P. Whitlock

The specimen which furnished the basis for this note was brought to the writer for identification in the fall of 1925 by Captain Thomas I. Miller, who obtained it for this purpose from the owner, a Paterson local collector. It was found in the Lower Quarry, at that time operated by Ferguson Bros. at West Paterson. Captain Miller stated that several small, isolated crystals had been obtained by the local collectors, who had assumed that they were wurtzite. The specimen consisted of a small but unusually well developed crystal of hexagonal hemimorphic symmetry, transparent, dark reddish brown in color, and measuring 2 mm. in diameter. The crystal was implanted on a rounded aggregate of light green prehnite in such a manner as to expose the planes of the posterior termination, which was uppermost, and to render practicable the measurement of these planes in four of the six sextants.

In the course of the identification of this crystal, measurement on a Goldschmidt 2-circle goniometer was resorted to, when it became apparent that the narrow limits of the ρ readings, using the perfectly reflecting basal plane for orientation, definitely identified the crystal as greenockite rather than wurtzite.

The following forms were observed on the posterior termination: *o* (0001), *m* $(10\bar{1}0)$, *k* $(20\bar{2}3)$, *r* $(10\bar{1}1)$, *s* $(20\bar{2}1)$ and *z* $(11\bar{2}1)$.

Figure 1 shows the proportional development of these planes in ideal representation. No measurements could be made of the anterior termination, owing to the position of the crystal with respect to the matrix; it was assumed, however, on a basis of surface markings, that the pyramid of the anterior termination was *r* $(10\bar{1}1)$, as represented in the figure.

The ρ angles measured on the occurring pyramids in four of the six sextants were as follows:

For *s* $(20\bar{2}1)$; 61° 55′, 61° 56′, 61° 55′, 61° 54′.
For *r* $(10\bar{1}1)$; 43° 8′, 43° 4′, 43° 6′, 43° 6′.
For *k* $(20\bar{2}3)$; 32° 7′, 32° 1′, 31° 57′, 31° 51′.
For *z* $(11\bar{2}1)$; 58° 22′, 58° 25′, 58° 24′, 58° 24′.

From these 16 readings, values of p_o were calculated which gave as an average $p_o = .93705$ with limits of .93908 and .93468, or about ± .002. This value of p_o corresponds to an axial ratio $a:c = 1:0.8115$. The value of p_o for greenockite, as given in Goldschmidt's "Krystallographische Winkeltabellen," is $p_o = .9374$. For wurtzite $p_o = .9442$.

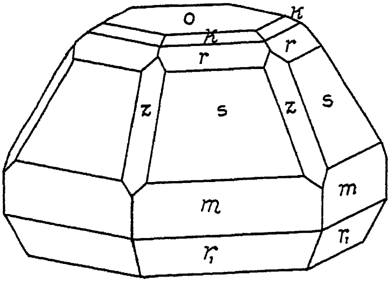

Fig. 1

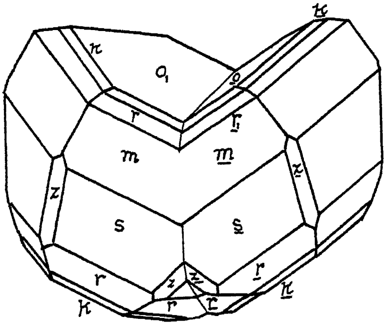

Fig. 2

A specimen from the Paterson quarry which was loaned to the writer for further study by Mr. James F. Morton, of the Paterson Museum, showed several small crystals of greenockite, one of which was twinned parallel to *z* $(11\bar{2}1)$. This constitutes a new twinning law for greenockite, since no twin crystals of this species have been hitherto observed. Figure 2 shows this twinning habit drawn in ideal proportions.

AMERICAN MUSEUM NOVITATES

Number 373
Published by
The American Museum of Natural History
New York City
Sept. 28, 1929

59 7,55 (87)

TWO NEW FISHES FROM MT. DUIDA, VENEZUELA

By Francesca La Monte

The specimens described below were collected by Mr. G. H. H. Tate, leader of the Tyler Duida Expedition, in two localities of the Mt. Duida neighborhood. Both streams are part of the upper Orinoco drainage: Burned Mountain Creek lying about five miles northeast of Caño Pescado, at 350 feet elevation, and Caño Pescado, about five miles north of Esmeralda, at an elevation of 325 feet.

Tateichthys, new genus

A genus of gymnotid fishes with frontal and parietal fontanels present, lower jaw included, head and body well compressed, teeth absent, no dorsal filament or caudal fin, no filaments in the mental region. The caudal filament is excerted and compressed, the sides of the entire body scaled, snout short and blunt and the orbital margin adnate.

Tateichthys duidæ, new species

Figure 1

The type, No. 9599, American Museum of Natural History, was taken in Burned Mountain Creek, November 25, 1928.

Body compressed, thickest immediately behind head; highest at origin of anal. Head rather chubby. Dorsal profile of head and body outline convex, ventral profile almost straight, slanting to anal origin and horizontal back of it. Body tapers rapidly to caudal filament, becoming very narrow over the last two-sevenths of the anal and passing into a well-developed caudal filament which is compressed and ends beyond the anal at a distance of about three times the length of the head. Body completely scaled; scales flimsy, cycloid, large anteriorly, growing smaller posteriorly.

Snout blunt, lower jaw included. Premaxillary and maxillary meeting at angle, maxillary curving backward and downward, not entirely exposed, reaching below eye. Anal with about 160–175 rays (fin mutilated in this and cotypes). No teeth, mental filament, dorsal filament, or caudal fin. Orbital margin not free. Eye not covered by membrane. Lateral line complete and conspicuous.

Total length to end of caudal filament, 149 mm.; length to end of anal fin, 95 mm. Greatest depth, 21 mm.; greatest thickness, 8 mm.; length of head, 15 mm.; thickness, 8 mm.; height, 17 mm. Eye small, 2 mm. Pectoral not as long as head and reaching slightly beyond origin of anal. Interorbital, 3.8 mm. Vent slightly in advance of the margin of the preopercle. Gill rakers (in a cotype), 4, close together in the center of arch. Fontanels present.

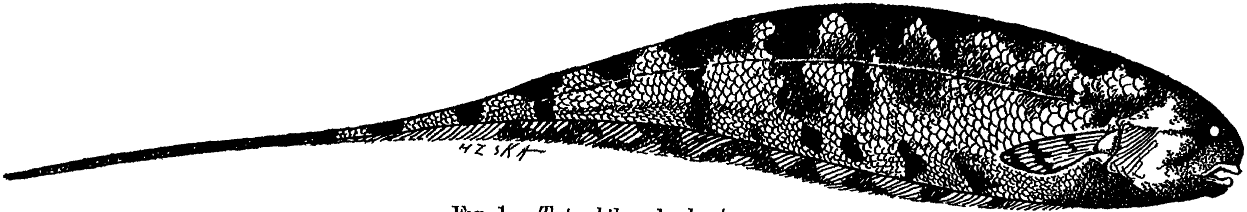

Fig 1 *Tateichthys duidæ*, type

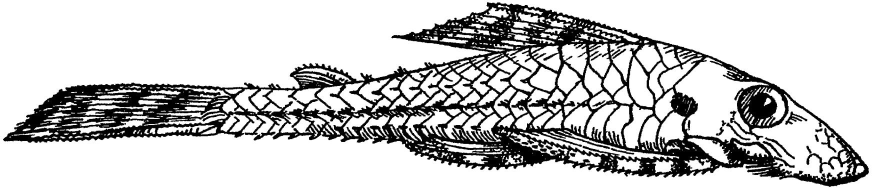

Fig 2 *Plecostomus niveatus*, type.

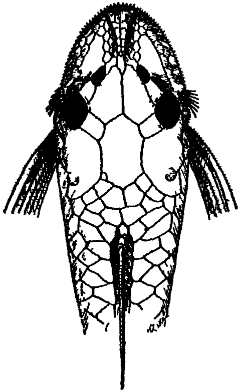

Fig. 3 *Plecostomus niveatus*, head

Color, in preservative: ground color, silvery buff. Dorsal ridge dark, saddled with unevenly triangular dark blotches, their base on ridge, straggling across lateral line. These blotches are more distinct in young. Another set of similar blotches, their base on the ventral body edge, extends upward, passing apex of descending set. A similar set on anal fin, base on the outer edge. Body covered with minute dark specks which are also present between the blotches on anal. Pectorals banded with spots. The body marking extends to the end of the caudal filament. Confused blotches and specks on head.

Comparative measurements of three specimens, 94 mm. to 103 mm. long to end of anal fin are as follows: depth in this length, 4.5.–5; head in same, 6.3–6.5; eye in head, 7–7.5; interorbital, 3.9–5; thickness of head and body, 1.9–2.5.

This gymnotid is easily recognized by its blunt head, well-compressed body which tapers rather abruptly behind and is more convex above than below, and sharply and regularly blotched color pattern. The type and one cotype were taken at the above locality; another cotype and two smaller ones, evidently young of the same species, were taken in Caño Pescado, on March 9, 1929.

Plecostomus niveatus, new species

Figures 2 and 3

One example, No. 9601, American Museum of Natural History, collected by Mr. G. H. H. Tate, in Caño Pescado, on March 9, 1929.

Total length, 105 mm.; length to base of caudal fin (used in mesaurements), 82 mm.

The head length is measured from tip of snout to posterior margin of temporal plate.

Depth in length, 6.8; head in length, 2.9. Depth of head in its length, 2.8; eye in head, 5.6; interorbital in head, 2.5; mandibular ramus in interorbital (across the arc), 1.6; (one side) 2. Dorsal, I, 7; anal, I, 4. Last ray of dorsal not adnate. Adipose present. Caudal short, obliquely truncate; caudal peduncle flat below. Pectorals to first third of ventrals; ventrals to first third of anal; last ray of dorsal, when depressed, two scutes from adipose; base of dorsal equals its own distance from adipose.

Maxillary barbel very small. Premaxillaries and dentaries about equal in length. Teeth in one row in each jaw, long, very slender, bifid, thick-set. Approximately 70 in upper and 68 in lower jaw.

Slight median ridge on snout before nostrils; supraorbital distinctly raised; supraoccipital flat, six-sided, bordered posteriorly by a pair of scutes. Behind this pair, another pair and a single median scute before dorsal spine. Top and sides of body covered with spiny scutes in five keeled series; 25 in lateral series; 7 between dorsal and adipose, 12 behind anal. Ventral surface of head and abdomen naked. Second scute of next to lowest series separated from temporal plate by a small scute of the series above. Snout covered to margin with small granular plates.

Opercle and interopercle connected tightly by membrane, not independently movable. Bunch of spines on interopercle, the longest not quite as long as diameter of eye; bristles on opercle and on sides of head and snout.

Color, in preservative, medium brown with conspicuous light spots everywhere except under surface of caudal peduncle which is plain buff. These spots smaller and more numerous on head. The naked ventral surface is darker but shows spotting.

AMERICAN MUSEUM NOVITATES

Number 374 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Oct. 3, 1929

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DANBURITE FROM OBIRA, JAPAN

BY HERBERT P. WHITLOCK

The material upon which this crystallographic study is based was furnished by a series of 13 loose crystals (catalogue number 17398) acquired by the American Museum in 1892 by exchange with Professor Takeo Wada, and labeled by him as coming from Obira, Bungo Province, Japan. A suite of five crystals was selected from this series and measured with the Goldschmidt 2-circle goniometer. The author takes this opportunity to express his thanks to Professor Wada for his kindness, by which this material has been made available for study.

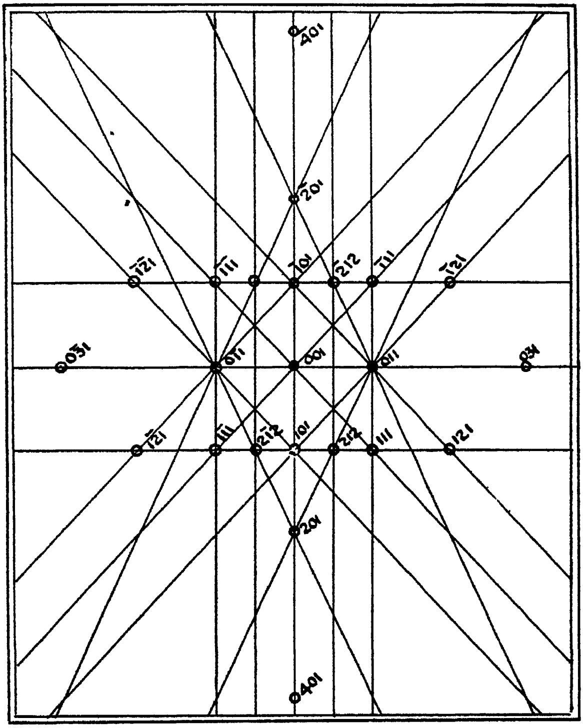

Fig. 1

Danburite crystals from Obira were studied in 1911 by Goldschmidt and Philipp,[1] who described 13 crystals selected from a series of 22. These authors also cited the previous work of Weber (1903) and Jimbo, Wada and Ko (1905), on Japanese danburite.

Goldschmidt and Philipp added eleven new forms to the species as a result of their studies and established a new and more accurate axial ratio.

The danburite crystals which are the subject of the present study average about 3 mm. in cross section by 12 mm. in length. They are water-clear and colorless, and are highly modified by many small planes, these being almost universally brilliant, and reflecting clear images of the goniometer signal.

The forms present on the five crystals selected for measurement, with their distribution, are given in the following table. Of the 49 forms observed, 31 are new for danburite.

FORMS			CRYSTALS					
			I	II	III	IV	V	
c	001	0	×	×	×	×	×	
a	100	∞0	×	×	×	×	×	
b	010	0∞	×	×	×	×	×	
L	920	$\frac{9}{2}\infty$		×			×	new
M	310	3∞	×		×	×	×	
n	210	2∞	×	×	×	×	×	
D	970	$\frac{9}{7}\infty$	×			×		
l	110	∞	×	×	×	×	×	
J	120	∞2	×	×	×	×	×	
z	013	$0\frac{1}{3}$			×			
d	011	01	×	×	×	×	×	
x	031	03			×			
y	072	$0\frac{7}{2}$				×		new
j	103	$\frac{1}{3}0$			×			new
t	101	10	×	×	×	×	×	
O	504	$\frac{5}{4}0$	×		×			new
w	201	20	×	×	×	×	×	
p	401	40	×	×	×	×	×	
R	601	60			×	×		
T	12 0.1	12 0				×		new
α	717	$1\frac{1}{7}$			×			new
β	616	$1\frac{1}{6}$	×		×	×		new
ϑ	515	$1\frac{1}{5}$				×		new
λ	212	$1\frac{1}{2}$	×	×	×	×	×	

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[1] Goldschmidt, V., and Philipp, H. 1912 'Ueber Danburit von Obira (Japan),' Zeitschr. f. Kryst. L, p 443.

(*Forms and Crystals continued*)

FORMS			CRYSTALS					
			I	II	III	IV	V	
π	858	$1\frac{5}{8}$					×	new
φ	323	$1\frac{2}{3}$					×	new
ζ	434	$1\frac{3}{4}$		×			×	new
ψ	767	$1\frac{6}{7}$					×	new
r	111	1	×	×	×	×	×	
e	121	12	×	×	×	×	×	
	449	$\frac{4}{9}$	×		×			new
v	112	$\frac{1}{2}$	×		×			
κ	559	$\frac{5}{9}$	×		×			new
𝔞	314	$\frac{3}{4}\ \frac{1}{4}$			×			new
𝔟	527	$\frac{5}{7}\ \frac{2}{7}$			×			new
𝔠	213	$\frac{2}{3}\ \frac{1}{3}$	×					new
Z	325	$\frac{3}{5}\ \frac{2}{5}$	×		×			
𝔡	347	$\frac{3}{7}\ \frac{4}{7}$	×		×			new
𝔢	123	$\frac{1}{3}\ \frac{2}{3}$	×					new
𝔣	257	$\frac{2}{7}\ \frac{5}{7}$		×				new
𝔤	716	$\frac{7}{6}\ \frac{1}{6}$			×			new
𝔥	514	$\frac{5}{4}\ \frac{1}{4}$	×					new
𝔩	148	$\frac{1}{8}\ \frac{1}{2}$	×		×			new
𝔪	4.5.10	$\frac{2}{5}\ \frac{1}{2}$			×			new
𝔬	548	$\frac{5}{8}\ \frac{1}{2}$	×		×			new
𝔭	10.7.14	$\frac{5}{7}\ \frac{1}{2}$			×			new
W	614	$\frac{3}{2}\ \frac{1}{4}$	×		×			
𝔫	10.2.7	$\frac{10}{7}\ \frac{2}{7}$	×					new
𝔮	958	$\frac{9}{8}\ \frac{5}{8}$		×				new
𝔯	14.4.5	$\frac{14}{5}\ \frac{4}{5}$	×					new
𝔰	14.3.4	$\frac{7}{2}\ \frac{3}{4}$	×					new
𝔲	152	$\frac{1}{2}\ \frac{5}{2}$			×			new

The general disposition of the principal poles of the form system of danburite in gnomonic projection is shown in Figure 1, which is drawn to a reduced scale to accommodate the size of the page. Figure 2 shows a quadrant of the gnomonic field, enlarged to show the intricate form system of this occurrence of danburite, the poles of the new forms being indicated in solid circles. As will be seen from Figure 2, a large proportion of the new pyramids lie in three well defined zones in which their harmonic relations will be presently discussed.

One new prism L (920) was observed once on each of crystals II and V. The average of these two readings gave:

Form		N	Observed		Calculated	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
L	920	2	78 36	90 00	78 28	90 00

Three new macrodomes were observed.

j (103) was observed once on crystal III, as a very narrow plane between (001) and (101)

0 (504) was noted twice on crystal I and once on crystal III as narrow but bright planes.

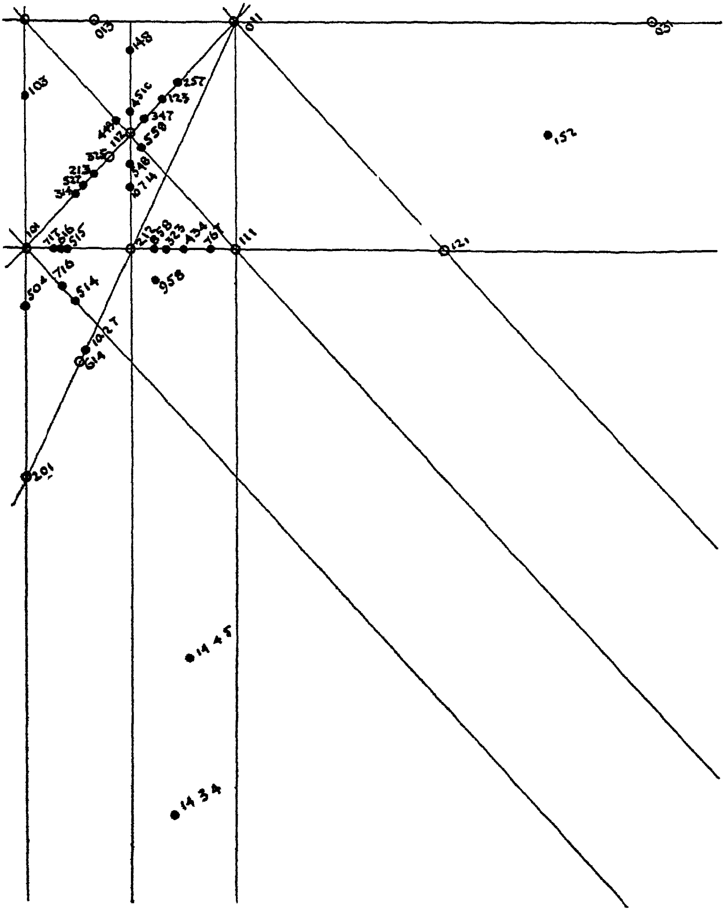

Fig. 2

T (12.0.1) was noted only once on crystal IV as a short narrow plane between (601) and (100).

FORMS		N	MEASURED				CALCULATED			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
j	103	1	90	3	18	1	90	0	17	45
O	504	3	90	3	49	54	90	0	50	12
T	12 0 1	1	90	3	85	27	90	0	85	2½

One new brachidome y (072) was observed as a small but bright trapezohedral plane.

FORMS		N	OBSERVED				CALCULATED			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
y	072	1	0	2	72	4	0	0	72	3

The zone between (011) and (101) as shown on Figure 2 is particularly rich in pyramids, including two that have been previously observed on danburite, and six that are new to the species. Developing the forms in this zone into a series we have:

	011	257	123	347	112	325	213	527	314	101
$\frac{h}{k}$	0	$\frac{2}{5}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$\frac{3}{2}$	2	$\frac{5}{2}$	3	∞
N_4	0 . .	$\frac{2}{5}$	$\frac{1}{2}$ . .	$\frac{3}{4}$	1 .	$\frac{3}{2}$.	2	$\frac{5}{2}$	3 .	∞

Referring this section of the zone to Normal Series 4, we have an incomplete zone with no extra forms, that is, no forms referable to a higher normal series than N_4.

𝔣 (257). This new pyramid was observed once only as a minute face on crystal II.

𝔢 (123). This new pyramid was observed twice on crystal I. The pole (123) also lies in zone [111:210].

𝔡 (347). This new pyramid was noted once on crystal I and once on crystal III.

z (325). This pyramid was observed by Goldschmidt and Philipp.[1] Like the preceding form it was noted on the present occurrence once on crystal I, and once on crystal III.

𝔠 (213). This new pyramid was observed three times on crystal I as a series of small narrow planes. Besides its excellent position in the zone under discussion, the pole (213) also lies at the intersection of the zones [031:$1\bar{1}1$], [103:110], [013:100].

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[1] Loc. cit.

𝔟 (527). This new pyramid was noted only once on crystal III as a small narrow plane. The pole (527) lies at the intersection of zone under discussion and [103:212].

𝔞 (314). This new pyramid, like the last discussed, appeared only once, as a small narrow plane on crystal III. The pole (314) lies at the intersection of the zone under discussion and [1̄21:152], [212:110].

Forms		N	Measured				Calculated			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
𝔣	257	1	22	58	34	35	23	32	34	27½
𝔢	123	2	28	37	33	53	28	34	33	47½
𝔡	347	2	39	35	33	17	39	14½	33	3
𝔷	325	2	58	29	34	9	58	31½	34	2
𝔠	213	3	65	17	35	17	65	20½	35	10
𝔟	527	1	70	57	36	32	69	50	36	9
𝔞	314	1	72	11	36	52	72	59	36	59

Developing the portion of the zone [011:101:110] that is included between (101) and (110) into a series, we have:

	101	716	514	211	110
$\frac{k}{l}$	0	⅙	¼	1	∞

The two new pyramids included in this section of the zone, (716) and (514), fall respectively in normal series N_6 and N_4. The pyramid (211) was not observed on crystals of this occurrence as at present studied, although appearing on material from other localities.

𝔤 (716). This new pyramid was observed once on crystal III, as a narrow but fairly bright plane. The pole (716) also lies in zones [112:21̄0] and [504:212].

𝔥 (514). This new pyramid appeared once on crystal I, as a small, bright, triangular plane. The pole (514) also marks the intersection of zones [111:152] and [201:112].

Forms		N	Measured				Calculated			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
𝔤	716	1	82	48	48	33	82	32	48	31
𝔥	514	1	79	48	50	10	79	36	50	41

The portion of the zone [101:111:010] that is included between (101) and (111) is particularly rich in new forms, no less than seven new pyramids falling between these limits. Developing this portion of the zone into a series and including the poles (313) and (535), representing forms previously observed on Japanese danburite, although absent from the present material, we have:

	101	717	616	515	313	212	535	858	323	434	767	111
$\frac{h}{k}$	∞	7	6	5	3	2	5/3	8/5	3/2	4/3	7/6	1
v–1	∞	6	5	4	2	1	2/3	3/5	1/2	1/3	1/6	0
N_4	∞	(6)	(5)	4	2	.1 .	2/3	3/5	1/2 .	1/3	. (1/6)	0

Referred to normal series 4 (N_4), this zone fragment is very incomplete, especially between (101) and (212), and contains three extra forms whose poles are situated close to the end knot points.

α (717). This new pyramid was noted once on crystal IV. Its zonal relations to the danburite form system are less satisfactory than any form hitherto discussed. The pole (717), however, lies in zone [347:210].

β (616). This new pyramid was observed once on each of crystals I, III, and IV. Its zonal relation to the form system of danburite are better than those for the form immediately preceding. The pole (616) lies at the intersection of the zone under discussion and [013:201] and [112:9$\bar{2}$0].

θ (515). This new pyramid was noted once on crystal IV as a narrow plane. The pole (155) also falls in zone [$\bar{1}$12:201].

π (858). This new pyramid, together with the three next to be discussed, was observed on crystal V, forming a group of narrow planes whose reflections of the goniometer signal followed one another in close sequence. The pole (858) also falls in zone [614:122].

φ (323). The pole of this new pyramid falls at the intersection of the zone under discussion and [112:310], [103.110] and [201.$\bar{1}$21].

ζ (434). This new pyramid was observed once on crystal II as well as on Crystal V. The pole (434) marks the intersection of the zone under discussion with [401.011] and [$\bar{5}$04.310].

ψ (767). The pole of this new pyramid falls at the intersection of the zone under discussion with [347.210] and [122.401].

Forms		N	Measured				Calculated			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
α	717	1	82	17	44	12	82	32	44	4½
β	616	3	81	19	44	23	81	18	44	10
ϑ	515	1	79	43	44	18	79	36	44	19
λ	212	15	.65	22	46	38½	65	20	46	34½
π	858	1	60	20	48	4	60	9	47	54½
φ	323	1	58	11	48	39	58	31	48	23
ζ	434	2	55	1	49	42	55	26	49	22
ψ	767	1	51	49	50	46	51	48	50	42

The zone that includes the prominent poles (112) and (212) also contains several new pyramids between a hyperthetical macrodome (012) and (212). Developing this zone fragment into a series, we have:

	012	148	4 5 10	112	548	10 7 14	212
$\frac{1}{h}$	∞	8	$\frac{5}{2}$	2	$\frac{8}{5}$	$\frac{7}{5}$	1
v–1	∞	7	$\frac{3}{2}$	1	$\frac{3}{5}$	$\frac{2}{5}$	0

In this series no term except 7, derived from (148), falls in a series higher than N_4, and $\frac{3}{2}$, derived from (4.5.10), falls in normal series N_3.

𝔩 (148). This new pyramid was observed 3 times on crystal I, and twice on crystal III. The pole (148) also lies at the intersection of zones [011.131] and [111.013].

𝔪 (4.5.10). This new pyramid was noted three times on crystal III. The pole [4.5.10] also lies at the intersection of the zone under discussion with [0$\bar{1}$2:121] and [325:2$\bar{1}$0].

𝔬 (548). This new pyramid was observed three times on crystal I, and twice on crystal III. The zonal relations of this form are very good. The pole (548) falls in the zones [013:$\bar{5}$04], [1$\bar{1}$1:031] and [504:011].

𝔭 (10.7.14). This new pyramid was observed once on crystal III. The pole (10.7.14) lies at the intersection of the zone under discussion and [2$\bar{1}$2.031].

			Measured				Calculated			
Forms		N	φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
𝔩	148	5	16	6	24	43½	15	14	24	33
𝔪	4 5 10	3	40	35	30	14	41	4	30	19
𝔬	548	5	53	38	36	38	53	42	36	34
𝔭	10 7 14	1	56	52	39	15	57	16	39	11½

The preceding discussion of the three zones of the form system of danburite, which, through the present study, have been proven to be rich in pyramid forms, has failed to include seven new pyramids which do not lie in any of these zones.

These will now be discussed in detail.

ι (449). This new pyramid in the zone [001:110] was observed four times on crystal I, and twice on crystal III. It lies at the intersection of zones ($\bar{4}$01.221) and (013.410).

κ (559). This new pyramid, also in zone [001:110], was observed twice on crystal I, and once on crystal III. The pole (559) also lies in zone [110.504].

q (958). This new pyramid was noted once on crystal II. The zonal relations of this form to the danburite form system are very good, the pole (958) marking the intersection of zones [111:152], [2̄01:112], [101:15̄2] and [011:31̄0].

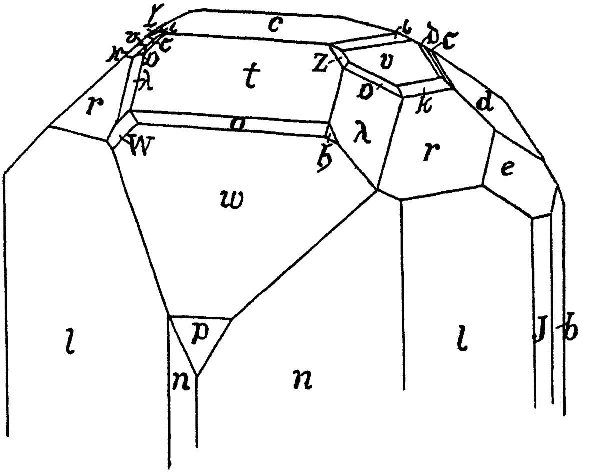

Fig 3

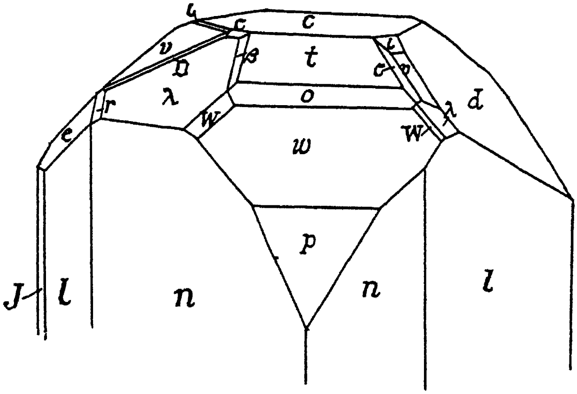

Fig. 4

n (10.2.7). This new pyramid was noted once on crystal I. The pole (10.2.7) lies at the intersection of the prominent zone [201.011] and [401.1̄12].

r (14.4.5). This new pyramid was observed twice on crystal I, in each instances as a very minute plane. The zonal relations of

[14.4.5] are very fair. It lies at the intersection of zones [401.121], [013.212] and [201.1$\bar{1}$1].

𝔣 (14.3.4). This new pyramid was observed 3 times on crystal I, in each instance as a very minute though bright plane. The pole (14.3.4) lies at the intersection of the prominent zone [201.210] with [504.310].

𝔲 (152). This new pyramid was observed twice on crystal III, both times as a small faint plane from which a reading was obtained with difficulty. The pole (152) falls at the intersection of the highly rational zones (031.121), (121.310) and (072.120).

FORMS		N	MEASURED				CALCULATED			
			φ		ρ		φ		ρ	
	°		°	′	°	′	°	′	°	′
ι	449	6	47	26	30	8	47	26½	30	6
κ	559	3	47	29	36	13	47	26½	36	33
𝔮	958	1	63	32	50	0	63	4½	50	35
𝔫	10 2 7	1	79	48	54	57	79	35	54	21
𝔯	14 4 5	2	75	7	70	44½	75	16	70	10½
𝔣	14 3 4	3	78	57	73	32	78	52	73	43
𝔲	152	2	11	43	65	56½	12	17	66	6

Figures 3 and 4 show two views of crystal I, drawn in actual proportion.

AMERICAN MUSEUM NOVITATES

Number 375 Published by The American Museum of Natural History New York City Oct. 5, 1929

59.57,7 (932)

DIPTERA COLLECTED BY PROF. AND MRS. COCKERELL IN NEW CALEDONIA AND FIJI ISLANDS

By C. H. Curran

During their extensive travels in the Orient and Australia, in the year 1928, Prof. and Mrs. Cockerell secured a fairly large number of flies, most of which have been donated to The American Museum of Natural History. Included in the collection were many interesting forms from New Caledonia and a few representatives from the Fiji Islands; these are included in the present report. The number of species recorded from New Caledonia is very small and, even though the present collection represents only a small portion of the insects collected during four weeks visit to the islands, it includes representatives of nineteen families, ten species new to science, and extends the known range of species described from various parts of Australia, the Orient, and Europe. Throughout the report the name of Prof. Cockerell has been omitted and it is to be understood that where no collector is named the flies were collected by him.

Tabanidæ

Tabanus rubricallosus Ricardo

Ricardo, 1914, Ann. Mag. Nat. Hist., XIII, p. 478.

A single female from Île Charron, June 5.

This is a grayish species with clear wings, subcallus pollinose, front wide, ocellar callus absent, frontal callus very large, mesonotum with two median whitish vittæ; abdomen with a pair of transverse brown triangles on bases of segments three to five, the lateral margins white pilose, the hair of the dorsum mostly black.

Two additional species, *T. albonotatus* Bigot and *T. caledonicus* Ricardo, have been recorded from New Caledonia.

Bombyliidæ

Villa basalis Macquart?

Anthrax basalis Macquart, 1855, 'Dipt. Exot.,' Suppl., V, p. 75.

A female collected at Plum Farm on June 4 by Mrs. Cockerell is referred to this species with doubt. Macquart described the male only;

the female agrees well with the description, but there is yellowish and not white pile on the sides of the apical segment, the costal cell is more brown than figured, and the appendage on the branch of the third vein is very short.

Dolichopodidæ

Condylostylus nuptus Bezzi

1928, 'Dipt. of Fiji Islands,' p. 67.

Two females from Suva, Fiji, June 25, 1928.

Chrysosoma leucopogon Wiedemann

Psilopus leucopogon Wiedemann, 1830, 'Ausser. Zweifl.,' II, p. 220.

Male and two females, Plum Farm, May 31, June 3, June 6; male and two females, Mueo, May 19; male, seacoast near Bourail, May 26; all New Caledonia, (Mrs. Cockerell), and female, Suva, Fiji, June 25.

Chrysotus cockerellæ, new species

Dark green; tibiæ and tarsi reddish yellow; halteres black. Most nearly related to *javanensis* de Meijere but at once distinguished by the reddish yellow tibiæ. Length, 1.75 mm.

Male.—Eyes contiguous below the antennæ, the face with grayish pollen; front with bronze tinge, the ocellar triangle and orbits blackish; hair of posterior orbits black; palpi brown, with pale brown hair. Antennæ black, the third segment small, much wider than long. Mesonotum with brownish pollen; pleura gray pollinose. Squamæ with black border and fringe; knob of halteres black. Legs black, the tibiæ and tarsi brownish yellow, the tarsi somewhat darkened apically; hair of legs conspicuous but not unusually abundant. Wings cinereous hyaline. Abdomen black-haired.

Female.—Face narrow, gray pollinose. Color, in general, brighter.

Types.—Holotype, male, Paita, May 17, 1928; allotype, female Mueo, May 19, 1928, (Mrs. Cockerell); paratype, male, Plum Farm, June 6, 1928.

Phoridæ

Aphiochæta species

A single specimen from Plum Farm, June 6, belongs to the group with long costal bristles. It is a blackish species with the legs partly obscure yellowish.

Syrphidæ

Melanostoma univittatum Wiedemann

Syrphus univittatum Wiedemann, 1830, 'Ausser. Zweifl.,' II, p. 139.

Six specimens of each sex from Plum Farm, May 31, June 7; Bourail, May 21, 24; Mueo, May 19, 20, (Mrs. Cockerell); female, Île Nou, June 10.

Ischiodon scutellaris Fabricius

Scæva scutellaris Fabricius, 1805, 'Syst. Antl.,' p. 252.

Female, Plum Farm, May 31.

Syrphus grandicornis Macquart

Macquart, 1842, 'Dipt. Exot.,' II, part 2, p. 96.

Female, Noumea, May 29, (Mrs. Cockerell).

Asarkina salviæ Fabricius

Syrphus salviæ Fabricius, 1794, 'Ent. Syst.,' IV, p. 306.

Male, Plum Farm, May 30, at flowers of *Poinsettia.*

Epistrophe viridaureus Wiedemann

Syrphus viridaureus Wiedemann, 1824, 'Anal. Ent.,' p. 35.

Female, Bourail, May 21, (Mrs. Cockerell).

Eristalis punctulata Macquart

Macquart, 1847, 'Dipt. Exot.,' Suppl , II, p. 59.

Two females, Bourail, May 24 and 26; male, two females, Plum Farm, June 4, 6 and 7; and female, Dge, June 6; all collected by Mrs. Cockerell.

Cscinidæ

Hippelates bilineatus de Meijere

de Meijere, 1904, Bijdr. Dierk., XVIII, p. 113.

Three specimens from Plum Farm, June 6 and one from Dge, June 6.

Drosophilidæ

Drosophila bilimbata Bezzi

Bezzi, 1928, 'Dipt. of Fiji Islands,' p. 159.

Female, Bourail, May 24.

Agrees with the description, except that the apices of the abdominal segments are somewhat darkened.

Ephydridæ

Psilopa nigritella Stenheimer

Stenheimer, 1844, 'Ephydr.,' p. 262.

Two females, Plum Farm, June 6, and female, Dge, June 6.

These agree with the description of the European form but males from both regions should be compared.

Psilopa compta Meigen

Notiphila compta Meigen, 1830, 'Suite Buffon,' VI, p. 68.

Two females, Plum Farm, June 6.

The specimens agree with the description of *compta* Meigen, but males from both regions should be compared.

Borboridæ

Limosina species

Male, Dge, June 6.

Without named specimens from the Old World for comparison, satisfactory identifications of species in this genus cannot be made.

Sepsidæ

Sepsis tenella de Meijere

de Meijere, 1906, Ann. Mus. Nat. Hung., IV, p. 183.

Saltelleseps tenella Duda, 1926. Ann. Naturhist. Mus. Wien, p. 43.

A single male, Plum Farm, May 31, (Mrs. Cockerell).

This species evidently belongs to *Sepsis*, although somewhat aberrant in wing venation.

Ortalidæ

Rivellia abana Curran

Curran, 1929, Amer. Mus. Novit., No. 339, p. 11, Fig. 1.

Described from sixteen specimens of both sexes from Plum Farm and Bailly Island, June 5, 6, and 7.

Trypaneidæ

Ensina conflicta Curran

Curran, 1929, Amer. Mus. Novit., No. 339, p. 11, Fig. 2.

Originally described from eight males and five females from Bailly Island and Dge, June 5 and 6.

Sapromyzidæ

There are four species, one of them from Fiji, in the collection.

Steganopsis melanogaster Thompson

Lauxania melanogaster Thomson, 1868, 'Eugenies Resa,' p. 567.

Eight specimens from Bailly Island, June 5; Dge, June 6; Plum Farm, June 6; and Île Nou, June 10.

Homoneura varia Kertesz

Sapromyza varia Kertesz, 1900, Term. Fuzet., XXIII, p. 257.

One specimen, Bailly Island, June 5.

Homoneura horvathi Kertesz

Sapromyza horvathi Kertesz, 1900, Term. Fuzet., XXIII, p. 260.

One specimen, Mueo, May 19, (Mrs. Cockerell).

Trypaneoides Tonnoir and Malloch

There are several species belonging to this genus in the Orient, all of them with the wings brownish, marked with hyaline spots or bands. The species listed below evidently belong here.

Lauxania bicincta de Meijere, 1910, Tijd. v. Ent., LIII, p. 138, Fig. Dutch East Indies.

Lauxania fenestrata de Meijere, 1910, Tijd. v. Ent., LIII, p. 139, Fig. Dutch East Indies.

Trypaneoides guttata Tonnoir and Malloch, 1926, Fig. New Zealand. Genotype.

Sapromyza nobilis Kertesz, 1900, Term. Fuzet., XXIII, p. 259. New Guinea.

Sapromyza pulcherrima Kertesz, 1900, Term. Fuzet., XXIII, p. 258. New Guinea.

Trypaneoides sumatrana Malloch, 1927, 'Suppl. Ent.,' XV, p. 105. Sumatra.

Lauxania tephritina de Meijere, 1914, Tijd. v. Ent., LVII, p. 227, Fig. Dutch East Indies.

Trypaneoides tricincta Malloch, 1927, 'Suppl. Ent.,' XV, 105. Sumatra.

Lauxania trypetiformis de Meijere, 1910, Tijd. v. Ent., LIII, p. 133, Fig. Batavia.

Sapromyza cirrhicauda Bezzi, 1928, 'Dipt. of Fiji Islands,' p. 129.

Sapromyza leucosticta Bezzi, 1928, 'Dipt. of Fiji Islands,' p. 132.

Trypaneoides caniventris Bezzi

Sapromyza caniventris Bezzi, 1928, 'Dipt. of Fiji Islands,' p. 131.

Male and female, Lautoka, Fiji, May 9.

Lonchæidæ

Lonchæa filifera Bezzi

Bezzi, 1913, Philippine Journ. Sci., VIIID, p. 320.

Male, Bourail, May 23–24, (Mrs. Cockerell).

Although the specimen is not in good condition and the arista is missing, the determination is probably correct.

Tetanoceridæ

Sepedon latus Bezzi

Sepedon costalis latus Bezzi, 1928, 'Dipt. of Fiji Islands,' p. 84.

A single female, Plum Farm, June 4, (Mrs. Cockerell).

Bezzi described this as a variety of *costalis* Walker but suspected that it was distinct, and in the same paper Major Austen confirmed this supposition.

Muscidæ

Stomoxys calcitrans Linnæus

Conops calcitrans LINNÆUS, 1761, 'Fauna Suec.,' 2d Ed., p. 467.

Female, Noumea, May 16.

Ophyra chalcogaster Wiedemann

Anthomyia chalcogaster WIEDEMANN, 1824, 'Anal. Ent.,' p. 52; 1830, 'Ausser Zweifl.,' II, p. 427.

Male and two females, Plum Farm, June 6, 1928; male, Bourail, May 22, 1928.

Limnophora plumiseta Stein

STEIN, 1903, Mitt. Zool. Mus. Berl., II, p. 109.

Male and six females, Bourail, May 22, 24; Dge, June 6; Plum Farm, June 4, (Prof. and Mrs. Cockerell).

This species was originally described from Egypt and later recorded from the East Indies by Stein.

ATHERIGONA Rondani

There are two species belonging to this genus from New Caledonia. One is a female related to *excisa* Thomson while the other, a male, lacks its legs and cannot be identified without material for comparison.

CŒNOSIA Meigen

There are three species from New Caledonia belonging to this genus in the collection and another species has been described by Bigot. The following table separates the species of *Cœnosia* and *Pygophora* before me from the island.

1. Arista bare[1] .... 2.
   Arista plumose .... 3.
2. Antennæ black .... *Cœnosia* species.
   Antennæ yellowish .... *C. pumilis* Stein.
3. Wings hyaline .... *C. macularis* Wiedemann.
   Wings with brown spot apically .... *Pygophora aliena* Malloch.

Cœnosia species

A female from Plum Farm, June 6, 1928, has the antennæ and palpi black, legs wholly yellowish and is about 3 mm. in length. Males are needed for identification.

---

[1] Bigot's description does not mention the arista, hence the species cannot be recognized.

Cœnosia pumilis Stein

STEIN, 1900, Term. Fuzet., XXIII, p. 151.

One male, Plum Farm, June 6.

Cœnosia caledonica Bigot

BIGOT, 1884, Ann. Soc. Ent. France, p. 269.

The abdomen is partly yellow and the thorax bears two slender, brownish vittæ.

Cœnosia macularis Wiedemann

WIEDEMANN, 1830, 'Ausser. Zweifl.,' II, p. 438.

Two females, Mueo, May 19.

Pygophora aliena Malloch

MALLOCH, 1922, Ann. Mag. Nat. Hist., X, p. 381.

A single male, Mueo, May 19, (Mrs. Cockerell).

Sarcophagidæ

Rhinia discolor Fabricius

Idia discolor FABRICIUS, 1794, 'Ent. Syst.,' IV, p. 320.

Male, Plum Farm, June 4; and female, Bourail, May 21, (Mrs. Cockerell).

Lucilia nosocomiorum Doleschall

DOLESCHALL, 1857, Natur. Tijd. Ned. Ind., XIV, p. 413.

Two males from Noumea, May 17, and one from Plum Farm, June 6.

CALLIPHORA Desvoidy

There are three species from New Caledonia belonging to this genus, two of them new to science.

1. Lower lobe of squamæ with long hair on upper surface (Calliphora)..........2.
   Lower lobe of squamæ bare on upper surface.... *Melinda minuta* Curran.
2. Abdomen chiefly yellowish ....*C. centralis* Malloch.
   Abdomen wholly green..3.
3. Small species, under 5 mm., genitalia as in figure....*C. melinda,* new species.
   Species of medium size, 9 to 10 mm., genitalia as in figure..*C. noumea,* new species.

Calliphora centralis Malloch

MALLOCH, 1927, Proc. Linn. Soc., N. S. W., LII, p. 311.

Male and female, Plum Farm, May 30 and 31, (Mrs. Cockerell).

Calliphora noumea, new species

Figure 1

Related to *metallica* Malloch by comparison of the male genitalia but at once separated by the dark thorax and genitalic differences. Length, 9.5 mm.

Male.—Head black; parafacials, anterior oral margin, palpi and antennæ reddish; third antennal segment somewhat brown on apical half. Head gray pollinose, the facial pollen with yellow tinge. Hair black, some yellow hair behind the mouth. Front scarcely as wide as the width of the ocellar triangle.

Thorax black, the mesonotum with metallic blue tinge, the whole thickly gray pollinose, the dark vittæ moderately distinct. Acrosticals, 2–3; dorsocentrals 3–3. Anterior spiracle orange, the border and upper edge brown. Hair wholly black.

Legs black, the tibiæ brownish, the anterior tibiæ with a single posterior bristle. Pulvilli brown.

Wings cinereous hyaline; squamæ brown with yellow rim, the immediate base white. Halteres yellow.

Abdomen green, quite thickly cinereous pollinose, very slightly tessellate; second segment without complete row of marginal bristles, with two or three laterally. Hair wholly black. Lateral view of genitalia as in figure 1.

Type.—Male, Noumea, May 17.

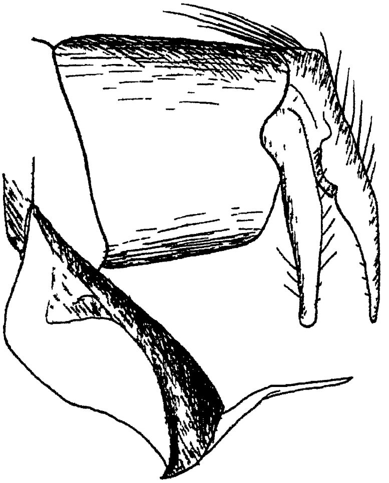

Fig. 1. *Calliphora noumea*, new species

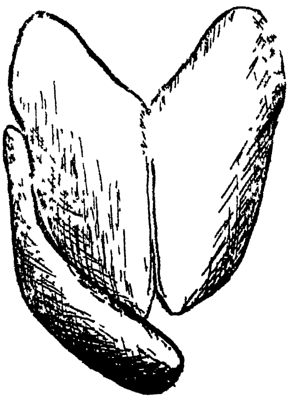

Fig. 2. *Calliphora melinda*, new species. Posterior and outer forceps of male genitalia.

Calliphora melinda, new species

Figure 2

At once distinguished from the remaining species is the genus by the broad and short posterior forceps in the male. It is readily separated from *minor* Malloch by the blackish thorax. Length, 4.5 mm.

Male.—Head black, cinereous white pollinose; face, palpi and antennæ reddish, the third antennal segment somewhat brown apically. Hair black, largely pale on the occiput. Front wider than ocellar triangle.

Mesonotum with bluish tinge, the thorax rather thickly cinereous pollinose, the vittæ distinct; hair wholly black. Anterior spiracle pale orange. Acrosticals, 2–3; dorsocentrals, 2–3.

Legs black; anterior tibiæ with a single posterior bristle. Pulvilli grayish brown.

Wings cinereous hyaline; squamæ with brownish tinge, especially on the disc. Halteres yellow.

Abdomen green, whitish pollinose; second segment with posterior bristles towards the sides but without a complete row; third segment with row of marginals. Posterior and outer forceps as in figure 2. Fifth sternite large, almost transverse apically with a deep U-shaped median emargination.

Female.—Front wide, with almost parallel sides; pollen grayish yellow.

Types.—Holotype, male, Mueo, New Caledonia, May 20, (Mrs. Cockerell); allotype, female, Noumea, May 29, 1928, (Prof. and Mrs. Cockerell).

The genitalia of this species indicate a strong relationship to *Melinda*, but the presence of pile on the lower squamal lobe causes it to be placed in *Calliphora*. The female traces to *minor* Malloch in Malloch's key.

Melinda minuta, new species

Figure 3

Similar in appearance to *Calliphora melinda* Curran but smaller, without squamal pile and with different genitalia. Length, 3.5 mm.

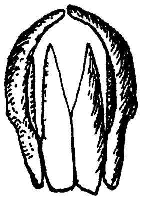

Fig. 3. *Melinda minuta,* new species. Male genitalia.

Male.—Head black, cinereous pollinose; face, palpi and antennæ reddish, the third antennal segment brownish apically. Hair black, partly whitish on the occiput. Front at narrowest part almost twice as wide as ocellar triangle.

Thorax black, cinereous pollinose, the mesonotum with more or less greenish reflection posteriorly. Hair wholly black. Anterior spiracle small, pale orange. Acrosticals, 1–2; dorsocentrals, 3 or 4–3.

Legs black; pulvilli rather small, brownish yellow.

Wings cinereous hyaline, squamæ grayish yellow. Halteres yellow.

Abdomen green, moderately cinereous white pollinose, third and fourth segments each with row of marginals, the second with three or four on either side. Posterior and lateral forceps as in figure 3.

Female.—Front of equal width, with two pairs of orbitals; outer verticals strong; dorsocentrals 2–3.

Types.—Holotype, male and allotype female, Île Nou, New Caledonia, June 10, 1928.

There are seven species belonging to the subfamily Sarcophaginæ, five of them previously known from Australia or Asia, two being undescribed. The table which follows will serve for the separation of the males.

1. First vein bare (*Sarcophaga*)..2.
First vein bristled..6.
2. Posterior tibiæ with long hair only on the posterior surface..................3.
Posterior tibiæ with long hair on antero- and postero-ventral surfaces.
S. knabi Parker.
3. Outer vertical bristles not developed..4.
Outer vertical bristles three-fourths as long as verticals. .*S. noumea*, new species.
4. Hair on anterior half of the cheeks black..5.
Hair on cheeks practically all yellow ....*S. gamma* Johnston and Tiegs.
5. Propleura haired in middle ....*S. peregrina* Desvoidy.
Propleura bare..*S. ceylonensis* Parker.
6. Apical cell long petiolate ....*Caledonia petiolata*, new species.
Apical cell open....................*Helicobia australis* Johnston and Tiegs.

Sarcophaga ceylonensis Parker

?*Sarcophaga misera* WALKER, 1849, 'List. Dipt.,' IV, p. 829. JOHNSTON AND TIEGS, 1921, Proc. Roy. Soc. Queensland, XXXIII, p. 67; 1922, Rec. Austr. Mus., XIII, p. 178. HARDY, 1923, Proc. Linn. Soc. N. S. W., XLVIII, p. 112.

Sarcophaga ceylonensis PARKER, 1923, Ann. Mag. Nat. Hist., (9) XI, p. 125.

A single male from Sandringham, Victoria, Australia, April 1, 1928, (Rayment and Cockerell).

There must be doubt concerning the identity of Walker's species, which was described from at least three females from Australia. Inasmuch as it is at present impossible to distinguish the females of related species with any degree of certainty it seems advisable to use the name proposed by Parker for what is evidently the species identified as *misera* by Australian workers.

Sarcophaga gamma Johnston and Tiegs

JOHNSTON AND TIEGS, 1921, Proc. Roy. Soc. Queensland, XXXIII, p. 60; 1922, XXXIV, p. 182; 1922, Rec. Austr. Mus., XIII, p. 180. HARDY, 1923, Proc. Linn. Soc. N. S. W., XLVIII, p. 125.

Sarcophaga brunneopalpis JOHNSTON AND TIEGS, 1922, Proc. Roy. Soc. Queensland, XXXIV, p. 184.

Male and two females, Bourail, May 22; female, May 23, (Mrs. Cockerell).

Sarcophaga knabi Parker

PARKER, 1919, Proc. U. S. Nat. Mus., LIV, p. 89.

Two males, Bourail, May 23–24, (Mrs. Cockerell); male, Lautoka, Fiji, May 9.

These specimens show slight differences from the figure given by Parker and from each other but they evidently belong here. The species was described from the Philippine Islands.

Sarcophaga peregrina Robinean Desvoidy

Myophora peregrina Desvoidy, 1830, 'Essai Myod.,' p. 356.

Sarcophaga peregrina Johnston and Tiegs, 1922, Rec. Austr. Mus., XIII, p. 177; 1922, Proc. Roy. Soc. Queensland, XXXIV, p. 182.

A single male from Levuka, Fiji Islands, May.

It is very doubtful that this is the species described by Desvoidy, since there are many species occurring throughout the oceanic region which agree fully with the poor description given by that author. Other species placed as synonyms of *peregrina* are: *subrotunda* Desvoidy, *rapida* Desvoidy, *irreguieta* Walker, and *ochripalpis* Thomson. None of these species are recognizable from the descriptions. *S. subrotunda* might well be the female of *peregrina* but, from the descriptions, it is almost certain that *rapida* and *ochripalpis* are not the same. *S. irrequieta* was described from a female and might be any one of a dozen species.

Sarcophaga noumea, new species

Figure 4

Superficially similar to *S. gamma* Johnston and Tiegs but at once distinguished by the male genitalia. Length, 13.5 mm.

Male.—Front five-sevenths as wide as greatest width of either eye, with eight pairs of frontals, the upper pair reclinate, the lower ones gently diverging; parafrontal at middle not half as wide as the black frontal vitta. Outer verticals strong; one row of bristles behind the eyes. Pollen of head golden yellow; hair of occiput and cheeks yellowish. Palpi blackish. Antennæ black, the third segment somewhat more than twice as long as wide.

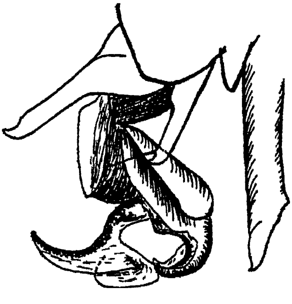

Fig. 4. *Sarcophaga noumea,* new species. Lateral view of male genitalia.

Pollen of thorax grayish yellow, the three vittæ very distinct; acrosticals 0–1; four postsutural dorsocentrals; propleura bare.

Wings cinereous hyaline; squamæ white; halteres with the knob somewhat darkened on outer surface.

Legs black; anterior and posterior femora each with one row of bristles below; middle femora with a row of bristles on either edge of the lower surface and with dense hair on the basal half of the anteroventral surface. Posterior tibiæ with long hair on posteroventral surface except basally. Pulvilli large, brown.

Abdomen grayish tesselate, with median vitta and two rows of black spots, when viewed from behind, the inner row elongate and rising at base of the segment, the outer row irregular and situated at or near the posterior borders. Fifth sternite with short, coarse hair along inner edge. Lateral view of genitalia as in figure 1.

Holotype.—Male, Noumea, May 16, 1928.

Helicobia australis Johnston and Tiegs

JOHNSTON AND TIEGS, 1921, Proc. Roy. Soc. Queensland, XXXIII, p. 50.

Male, seacoast near Bourail, May 25, (Mrs. Cockerell); two females, Île Nou, June 10.

CALEDONIA, new genus

In many respects similar to *Malacophagula* Bequaert but differeing as follows: head not rounded, the occiput not unusually prominent; one pair of proclinate orbitals present; outer verticals strong; antennæ reaching three-fourths the distance to the oral margin. First wing vein with strong bristles; abdomen with dorsal marginals. The wing venation is quite as in *Malacophagula* except that the third vein ends slightly nearer the wing-tip. Acrosticals, 0–1; dorsocentrals, 1–3; 1 sublateral, no posthumeral; one supra-alar and one intra-alar; four notopleurals, two of them weak; two sternopleurals; propleura bare; no infrasquamal setulæ. Legs simple; pulvilli of medium size. Abdomen without discals; second and third segments with pair of marginals, the fourth with a row; first and second segments each with one lateral marginal, the third with two.

GENOTYPE.—*Caledonia petiolata*, new species.

Bequaert has published illustrations of *Malacophagula neotropica* (Journ. of Parasitology, 1925, XI, p. 207). He found the species to be parasitic on a snail and it is not improbable that *Caledonia* has the same habit.

Caledonia petiola, new species

Sarcophaga-like in appearance, but with the abdomen only very weakly tesselate Length, 4 mm.

MALE.—Head gray pollinose, the cheeks and face with yellow tinge; front with parallel sides, two-thirds as wide as greatest width of either eye, the blackish frontal vitta one-third narrower than either parafrontal; five pairs of frontals, the lowest slightly below the base of the antennæ, together with the two adjacent pair convergent, the upper two pairs are much stronger and reclinate, the anterior pair situated at the lower third of the front, the other at the upper third; ocellars weak. Head with black bristly hair, a small amount of pale hair below the neck. Cheeks one-fourth as wide as eye-height. Oral margin not as prominent as antennal base, slightly produced. Parafacials narrow, with a single row of hairs, two or three of the lower ones bristlelike. Palpi rather slender, brown. Antennæ blackish, the third segment not twice as long as the second; arista plumose on basal half.

Thorax gray pollinose, the pleura with yellowish tinge; mesonotum with three brown vittæ, the median one extending onto the scutellum.

Wing veins yellowish basally; squamæ with yellow tinge; knob of halteres brown.

Basal two-thirds of the second to fourth abdominal segments and a large spot on either side of the apical half of the first segment, yellowish gray pollinose, the gray bands rather broadly interrupted in the middle.

HOLOTYPE.—Male, Bailly Island, New Caledonia, June 5, 1928.

Tachinidæ

Microceromasia caledonia, new species

Differs from *M. sphenophori* Villeneuve in having the thorax almost evenly pollinose behind the suture. Length, 4.75 mm.

MALE.—Head black, silvery white pollinose, the frontal vitta deep black, wider than either parafrontal; six or seven pairs of frontals; two pairs of orbitals; front five-sevenths as wide as greatest width of eye; outer verticals absent; no setæ behind the black occipital cilia. Cheeks one-sixth as wide as eye-height; parafacials narrow, slightly widening above. Palpi brown. Antennæ black, reaching almost to the vibrissæ; the third segment five times as long as the second, rather acute at dorsal apex; arista long, bare, thickened on basal third.

Thorax black, black-haired; mesonotum with grayish pollen in front, immediately before the suture, laterally in front of the suture and before the scutellum, in some lights with three blackish vittæ in front of the suture, in other lights with four vittæ, the mesonotum otherwise and the scutellum brownish pollinose; pleura whitish pollinose. Acrosticals and dorsocentrals 3–3; posterior sublateral and posthumeral absent; three pairs of scutellars, the second pair longest, the apical pair cruciate; sternopleurals in an almost equilateral triangle.

Legs black; pulvilli small; middle tibiæ with a single anterior bristle; posterior tibiæ with three or four anterodorsal and two posterodorsal bristles.

Wings tinged with brown, paler apically and posteriorly; apical cell ending moderately before the wing-tip; third vein with a single basal bristle. Squamæ large, whitish with faint brownish yellow tinge. Halteres reddish yellow.

Abdomen shining black, a little more than the basal third of the second to fourth segments white pollinose, the posterior border of the pollen not sharply defined; first and second segments each with pair of strong marginals, third and fourth with row; no discals. Genitalia small, concealed.

HOLOTYPE.—Male, Bailly Island, June 5, 1928.

This species may not belong to *Microceromasia* Villeneuve but it is impossible to decide its exact status. I have seen specimens from Australia identified as *M. sphenophori* Villeneuve, the type of the genus: these specimens have the posterior sublateral bristle present but this character is not mentioned in the description. Bezzi, in his 'Diptera of Fiji Islands,' states that the arista is pubescent in the species, but Villeneuve makes no such statement. The genus is somewhat related to *Epiphanocera* Townsend from Peru, but that genus has the cheeks almost one-third as wide as the eye-height.

Stomatomyia tricholygoides Bezzi

BEZZI, 1928, 'Dipt. of Fiji Islands,' p. 205.

Three males from Plum Farm, May 30 and June 4, and female, Noumea, May 29, (Prof. and Mrs. Cockerell).

These specimens agree perfectly with the description given by Bezzi, except that he states that the acrostical and dorsocentral bristles are

"3–2." This is quite evidently an error, as this arrangement of the bristles in the group never occurs. These bristles are arranged 3–3 in my specimens and this is probably what was intended by Bezzi. The genus *Phœniciomyia* Townsend, described for a species from Arizona is very close to *Stomatomyia* Brauer and Bergenstamm, or at least to the specimens before me according to the description. It is possible that *tricholygoides* Bezzi belongs to *Phœniciomyia* and not to *Stomatomyia*, but the types of the two genera must be compared before any definite conclusions can be reached.

Nemorilla oceanica, new species

Differs from *maculosa* Meigen in lacking discal bristles on the abdominal segments and relatively longer third antennal segment. Length, 6.25 mm.

MALE.—Black, with brownish and cinereous pollen. Head with whitish pollen, that on the cheeks and front brownish. Nine or ten pairs of frontals, none reclinate; outer verticals weak; a single row of occipital cilia; occipital pile whitish. Front about half as wide as greatest width of eye. Palpi and antennæ blackish, the latter reaching almost to the vibrissæ, the third segment reddish at base, about one and one-half times as long as the second; arista thickened on basal two-fifths, obscurely pubescent.

Thorax with brownish pollen, the sides of the mesonotum and two or four obscure, narrow vittæ on the anterior half of the dorsum, grayish, the pollen on the anterior part of the pleura with grayish tinge. Acrosticals 3–3; dorsocentrals 3–4; sternopleurals 1–1; three pairs of strong marginal scutellars and a weak cruciate apical pair.

Legs black; middle tibiæ with a single anterior bristle; posterior tibiæ evenly ciliate anterodorsally; pulvilli long, yellowish.

Wings cinereous hyaline, the veins blackish basally; third vein with two basal bristles. Squamæ whitish with yellow tinge on margin. Halteres yellow.

First abdominal segment not pollinose. Apical third of second, fourth of third and half of the fourth segment brownish pollinose, the bases of the segments cinereous, a median vitta which forms an oval spot on the second segment almost bare. First and second segments with pair of marginals, third and sixth with row, the fourth with discals; posterior forceps brown, outer forceps reddish. The sides of the second and third segments are more or less reddish but the color is obscured by the pollen.

TYPES.—Holotype, male, Mueo, New Caledonia, May 19, 1928; paratype, male, north of Bourail, May 19.

Sturmia ciliipes Macquart

Tachina ciliipes MACQUART, 1843, 'Dipt. Exot.,' II, part 3, p. 62.

Female, Mueo, May 20, and female, seacoast near Bourail, May 26, (Mrs. Cockerell).

Hippoboscidæ

There are two species belonging to this family, but with the material before me I am unable to arrive at any conclusion as to the identity of one of them.

Hippobosca species

A female from Plum Farm, June 2, (no host).

The scutellum is stramineus with brown border, femora with a brownish median spot above and their apices brown; median and hind tibiæ with brown or black basal band, the posterior tibiæ with black apical band.

Ornithoctona nigricans Leach

Ornithomyia nigricans Leach, 1818, Mem. Wern. Nat. Hist. Soc., II, p. 558, Figs. 7–10.

Female, Plum Farm, May 3, on small hawk, (Miss Bloa and Prof. Cockerell).

AMERICAN MUSEUM NOVITATES

Number 376 | Published by The American Museum of Natural History New York City | Oct. 7, 1929

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ADDITIONS TO THE FAUNA OF THE GASHATO FORMATION OF MONGOLIA[1]

By W. D. MATTHEW, WALTER GRANGER, and GEORGE GAYLORD SIMPSON

In 1923 a small collection of fossil mammals was made from the Gashato Formation, which unconformably overlies the Djadokhta Formation near Shabarakh Usu in the Gurbun Saikhan Basin, north of the eastern end of the Altai Mountains. This collection was described in 1925.[2] In that year a second, larger collection was made from these beds, including the remains of five new genera and six new species. The multituberculates have already been discussed,[3] and preliminary descriptions of the remaining new forms are given in the present paper. A revised faunal list follows:

MULTITUBERCULATA
  Tæniolabididæ
    Prionessus lucifer Matthew and Granger, 1925
    Sphenopsalis nobilis Matthew, Granger, and Simpson, 1928
?INSECTIVORA
  ?Leptictidæ
    Praolestes nanus, new genus and species
  Inc. sed.
    Pseudictops lophiodon, new genus and species
?GLIRES
  Eurymylidæ, new family
    Eurymylus laticeps Matthew and Granger, 1925
CREODONTA
  ?Oxyclænidæ
    Hyracolestes ermineus Matthew and Granger, 1925
  ?Hyænodontidæ
    Opisthopsalis vetus, new genus and species
  Inc. Sed.
    Sarcodon pygmæus Matthew and Granger, 1925
?CONDYLARTHRA
  Inc. sed.
    Phenacolophus fallax Matthew and Granger, 1925

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 93

[2] Matthew, W. D., and Granger, W. Amer. Mus. Novitates, No. 189.

[3] Matthew, W. D., Granger, W., and Simpson, G. G. 1928, Amer. Mus. Novitates, No. 331.

AMBLYPODA
  Uintatheriidæ
    Prodinoceras martyr, new genus and species
NOTOUNGULATA
  Arctostylopidæ
    Palæostylops iturus Matthew and Granger, 1925
    Palæostylops macrodon, new species

On the basis of the first collection, Matthew and Granger (1925, pp. 1–2) concluded that "the presence of a multituberculate suggests Paleocene or late Cretaceous age; the ancestral relationship of *Palæostylops* to the Wasatch genus *Arctostylops* is indicative of Paleocene, Torrejon or possibly older age. The remaining genera throw no light upon the correlation . . . but they are not incongruous with a Paleocene fauna, although not representing the ancestral relationship to the Eocene faunæ of Europe and America that had been anticipated."

Most of the mammals of the Gashato appear to represent phyla previously unknown. From the standpoint of European and American early Tertiary mammals they are aberrant, and, despite their early age and primitive stamp, they are for the most part too specialized and peculiar to cast much light either on phylogeny or on correlation.

Including multituberculates, creodonts, and ungulates of archaic character, the fauna is, however, definitely of Paleocene type. As previously noted, *Palæostylops* is clearly allied to the Wasatch *Arctostylops* and is slightly less advanced than the latter. To this is now added the still more definite evidence of *Prodinoceras*, which is closely related to an undescribed genus from the Clark Fork, uppermost Paleocene, of Wyoming. *Prodinoceras* may be a little more advanced than the Clark Fork genus, but this would not necessarily militate against their essential contemporaneity, especially if, as seems probable, Mongolia was closer than Wyoming to the center of origin of the uintatheres. Rodents do not occur in the American or European Paleocene, but *Eurymylus*, even if it prove to be a true rodent, is not nearly related to any other known genus and the earlier presence of the Order in Mongolia would not be anomalous.

More exact correlation of so peculiar an assemblage cannot now be definitively made, but the rather specialized nature of its members and the relationship of *Prodinoceras* to the Clark Fork genus suggest that it belongs in the later Paleocene.

The known Paleocene mammal horizons of the world may be tentatively correlated as follows:

	North America				Europe	Asia
Upper	Tiffany	Clark Fork	Fort Union	Paskapoo	Cernaysian	Gashato
Middle	Torrejon					
Lower	Puerco					

The drawings in this paper are by John Germann.

Praolestes nanus, new genus and species

TYPE.—Amer. Mus. No. 21718, part of left lower jaw with last premolar and first two molars.

CHARACTERS.—Last premolar moderately compressed, with sharp, recurved main cusp, distinct anterointernal accessory cusp, very inconspicuous cuspule on posterointernal slope of main cusp, and well developed but unbasined heel with a single cusp. M_1 with only one heel cusp and no true talonid basin; trigonid about as long as broad, with high protoconid, low paraconid, and intermediate metaconid. M_2 with anteroposteriorly compressed trigonid, metaconid relatively large, paraconid relatively smaller, basined talonid nearly as wide as trigonid, with small entoconid and strong, elevated hypoconid. Anteroexternal cingula on molars, nearly vertical on M_1, more sloping on M_2. Length P_4-M_2 about 4.5 mm.

This very diminutive jaw somewhat resembles that of *Hyracolestes ermineus* from the same formation. The latter, however, is about 45 per cent. larger, with P_4 higher and more slender and its heel and cuspules less developed, no cingula on M_{1-2}, M_2 with trigonid relatively longer, paraconid relatively higher, talonid more elongate and with larger, less internal entoconid, the hypoconid (broken) probably less dominant, the jaw relatively stouter.

Praolestes appears to be an insectivore and is possibly a leptictid, although its P_4 is less molariform than in the known leptictids with the exception of the quite different *Acmeodon.* M_1 is peculiar and more resembles P_4 of the Leptictidæ. This tooth of *Praolestes* must be a molar, however, as it does not belong to the deciduous dentition and is on a level with the fully molariform tooth which follows it, while that which precedes it is as yet only partially protruded.

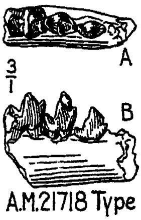

Fig. 1. *Praolestes nanus,* new genus and species. Part of left lower jaw with P_4 and M_{1-2}. Type. A, crown view. B, internal view. Three times natural size.

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[1] πρᾶος, meek.

Pseudictops lophiodon, new genus and species

TYPE.—Amer. Mus. No. 21727, part of left lower jaw with P_3–M_3.

PARATYPE.—Amer. Mus. No. 21712, part of right upper jaw with two cheek teeth.

CHARACTERS.—P_3 with the protoconid and the somewhat lower metaconid forming a cross crest; paraconid small, anterior and slightly internal to the protoconid; small basined heel with raised posterior rim, obscurely cuspidate. P_4 larger; trigonid essentially a short, transverse crest; metaconid slightly higher than protoconid; paraconid vestigial, anteromedian, united to the protoconid by a small secondary crest; heel low, short, transverse, posterior rim raised, with distinct hypoconid· M_1 smaller than P_4, $M_{1\text{-}3}$ progressively larger. Molar trigonids strongly compressed anteroposteriorly, progressively higher relative to talonids. Paraconids vestigial, united to protoconids by small secondary crests, internal on M_1, progressively less so on $M_{2\text{-}3}$. Molar talonids basined, narrower than trigonids, short and small on $M_{1\text{-}2}$ and with distinct hypoconids, more elongate on M_3, with elevated hypoconulid, small but distinct hypoconid, and obscure entoconid. P_4-M_3 with small anteroexternal cingula. Lower jaw of moderate depth, stout transversely.

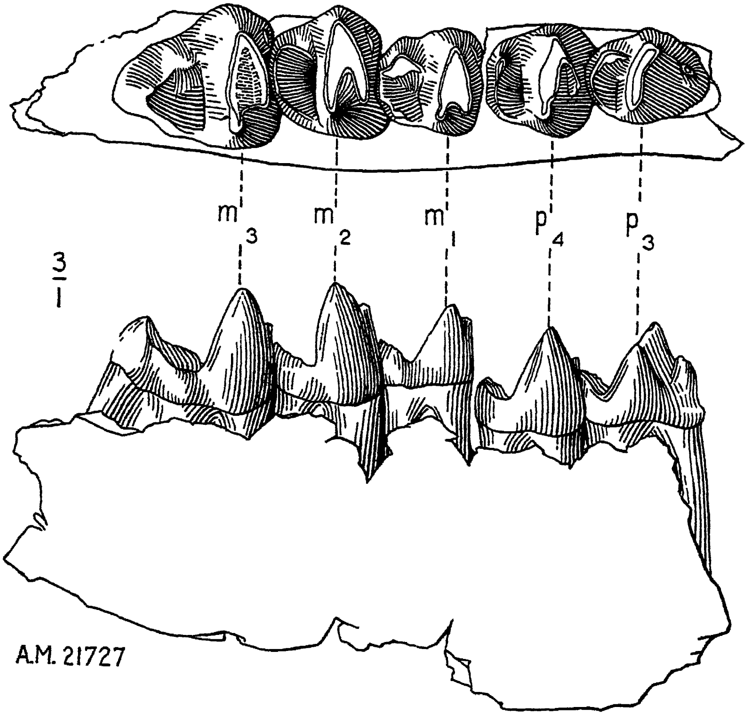

Fig. 2. *Pseudictops lophiodon,* new genus and species. Part of left lower jaw with $P_{3\text{-}4}$ and $M_{1\text{-}3}$. Type. Crown and internal views. Three times natural size.

Known upper cheek teeth (paratype), probably M^{1-2}, strongly transverse, with short, crescentic protocone; conical, high paracone and metacone, bases connate; distinct parastyle, smaller metastyle, narrow anterior cingulum; well marked, basined, non-cuspidate posterior cingulum rising to protocone. P^4 (part of alveolus) probably wider than M^1. M^2 slightly larger and more transverse than M^1. M^3 (alveoli) as large as M^2 or larger.

Despite its large size, this genus is suggestive of the Leptictidæ, although this resemblance is not sufficiently close necessarily to indicate true relationship. The molarization of the premolars has gone farther than in any leptictid, the bilophodont lower molars are not very closely paralleled in that group; the cheek teeth of the latter do not increase in size posteriorly as in *Pseudictops*, and their upper molars always have a hypocone which does not closely correspond to the posterior cingulum of *Pseudictops* in its relationship to the protocone.

The Cretaceous *Zalambdalestes* from an earlier formation near the same locality is leptictid in aspect and to that extent resembles *Pseudictops*, but there are no indications of special affinity.

The complication of the premolars, lophiodont lower molars, reduced paraconids, short heels on M_{1-2}, and retention of triangular upper molars recalls the Amblypoda, but the resemblance is even less close than to the Leptictidæ.

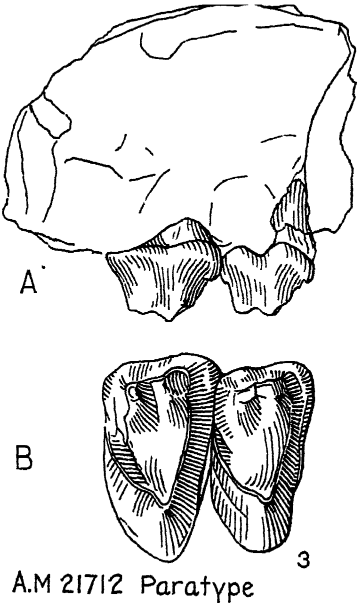

Fig. 3. *Pseudictops lophiodon*, new genus and species. Part of right upper jaw with two cheek teeth. Paratype. A, external view. B, crown view. Three times natural size.

Eurymylidæ, new family

Provisional Definition.—Cheek teeth P^2_2 M^3_3. Lower incisor fully gliriform, extending far back beneath cheek teeth. Lower cheek series hypsodont, rooted, with elevated trigonids and low talonids, each wearing to a transverse enamel ring. Upper cheek teeth strongly transverse, tritubercular, with a tendency to form anterior and posterior molar cingula. Masseter origin confined to zygoma, insertion not extending forward of posterior end of M_3. Infraorbital foramen small.

If other members of the family are found, it may well prove that not all of the above characters do apply to them, but there is no doubt that *Eurymylus* should be placed in a family distinct from any previously defined.

Eurymylus laticeps Matthew and Granger, 1925

SYNONYM.—*Baënomys ambiguus* Matthew and Granger, 1925.

Restudy with additional specimens indicates that *Baënomys ambiguus* and *Eurymylus laticeps* are respectively the lower and upper jaws of the same species. Published simultaneously, the latter name is selected as definitive, being based on a better type.

Two new lower jaws (Nos. 21735 and 21738) reveal the structure of P_{3-4}. P_3 is a plump tooth implanted by two roots, with an elevated anterior cusp, its apex somewhat transverse and higher externally, a minute cuspule on its anterior side, and a low broad heel which bears a transverse ridge. P_4 is nearly as large as the molars which follow it, and it has an elevated trigonid with two main, blunt, subconical cusps, the internal one somewhat the higher. Between these anteriorly is a small cuspule. The heel is low and when unworn has two small transverse ridges united externally. The molars are as described for the type of "*Baënomys ambiguus,*" and in all cases are too worn to make out the original cusp structure. In No. 21738, P_4 is smaller than in No. 21735, and they may prove to represent distinct species.

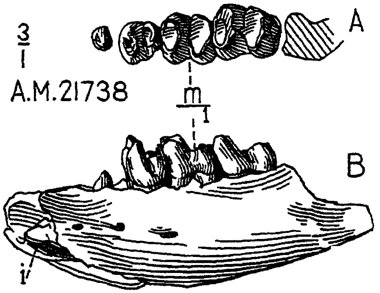

Fig. 4. *Eurymylus laticeps* Matthew and Granger. Left lower jaw with part of incisor, P_{3-4}, and M_{1-2}. Referred specimen. A, crown view. B, external view. Three times natural size.

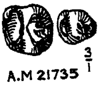

Fig. 5. *Eurymylus laticeps* Matthew and Granger. Right P_{3-4}, crown view. Referred specimen. Three times natural size.

Much of the intra-alveolar portion of the incisor is preserved in both of the new specimens and it is seen to be of persistent growth, extending back beneath the molars, slightly wider than deep, the enamel confined to the broad inferior, or anterior, face, which is flat and bounded by sharp angulations externally and internally.

No. 21737 is a left upper jaw with all the cheek teeth, but it adds little to what was known from the type of *Eurymylus laticeps.* On P_4 a distinct cingulum passes anterior to the paracone, and there is a slight shelf external to this cusp. On M^1 the same features are present, but less distinct, and on M^2 they are not observed. M^{1-2} and probably also P^4 have a definite posterior cingulum which ends in a small cusp posterior and slightly internal to the metacone. On M^3 this feature is still more strongly developed and forms a prominent part of the crown. The region between the protocone and the external cusps is worn in the known material.

The anterior root of the zygoma is above the three anterior cheek teeth. The infraorbital foramen is small and is slightly anterior to the roots of the first cheek tooth.

This genus is so isolated that its affinities remain in doubt. The isolated upper cheek teeth were referred tentatively to the Menotyphla (with *Plesiadapis* and its allies in mind). The lower jaw was referred to the Glires and here left *incertæ sedis*, although compared with the heteromyids on one hand and the lagomorphs on the other. The zygomatic arch is not like that of known rodents, but the evidence in hand does not more strongly favor any other allocation.

If *Eurymylus* is a rodent, it is the oldest known, primitive in many respects, but peculiarly and aberrantly specialized in others. In both upper and lower teeth there is a superficial resemblance to the lagomorphs, but in some characters it is more specialized than even the recent Lagomorpha, and these specializations are in a direction so unlike any known member of the group that it is probable that *Eurymylus* does not belong in the duplicidentate division of the Order. To the non-lagomorph characters of the lower jaw previously mentioned (Matthew and Granger, 1925, p. 6) may be added the fact that the incisor in *Eurymylus* extends far back beneath the cheek teeth. The upper teeth are indeed transverse, but otherwise they show little evidence of lagomorph specialization and, even aside from the absence of P^2, more definitely resemble the primitive simplicidentates.

The upper teeth do not strengthen the resemblance to the heteromyids. They might conceivably have given rise to those of some members of this family, but the gap is much too great to be filled by inference. There is a more definite resemblance to some of the earlier simplicidentates, such as *Paramys* and its allies, but the differences are striking, and the resemblance, if not wholly deceptive, may indicate only common derivation from the ultimate (Cretaceous) simplicidentate ancestry. The upper cheek tooth formula is the same, and the presence of two lower premolars, while striking, is primitive. Although different in proportions, the trituberculer upper molars with incipient anterior and posterior cingula are not very unlike those of some sciuromorphs, and M^3, with its almost basin-like posterior expansion, is more definitely similar. The lower molars have very evident traces of a tuberculo-sectorial ancestry, and their transverse trigonids and sharp division between trigonids and talonids are approached by some sciuromorphs, but the detailed specialization is along unfamiliar lines.

Opisthopsalis[1] **vetus,** new genus and species

TYPE.—Amer. Mus. No. 21701, very badly crushed skull and jaws.

CHARACTERS.—Dentition $\frac{?.1\ ?4.3}{?\ 1.\ 4.3}$. Canines moderately developed, laniary. P_4 elevated, carnassial, with distinct paraconid and metaconid and low, unbasined heel. M_1 relatively small, trigonid with subequal protoconid and metaconid and slightly smaller, internal paraconid; talonid slightly narrower than trigonid, basined, with three cusps, the hypoconulid somewhat the highest. M_3 large, with elevated, strongly carnassial trigonid, metaconid (broken in type) apparently present but smaller than paraconid; heel long and narrow, with three cusps, elevated hypoconulid. Jaw slender. P^2 with simple, high, slender crown. M^3 small, transverse, metacone reduced, strong parastylar spur. Length of skull about 60 mm. (much crushed). Brain case very long and narrow, with prominent sagittal and lambdoid crests.

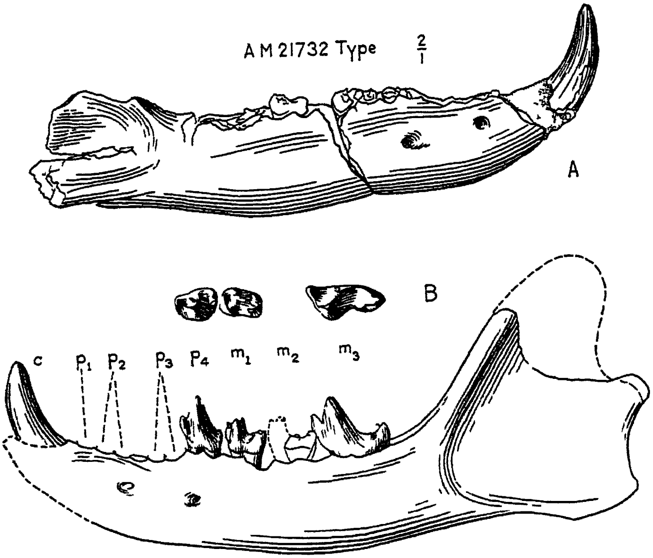

Fig. 6. *Opisthopsalis vetus*, new genus and species. A, right lower jaw with canine, external view. B, left lower jaw with canine, P_4, M_1, and M_3, external view, and crown view of preserved cheek teeth. Distortion of left lower jaw corrected. Type. Twice natural size.

The type of this species is a skull, with articulated lower jaws, nearly complete, but so crushed and broken as to yield few definite characters. The right lower cheek teeth and most of those of the upper jaws were crushed out of place and reduced to minute, irretrievable fragments, but by painstaking separation of the jaws several teeth of the left lower series were exposed nearly in place.

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[1] ὄπισθεν, behind; ψαλις, scissors—in allusion to the carnassial posterior lower molar.

It is possible that this is the same genus as *Sarcodon*, based by Matthew and Granger on a first or second upper molar, but direct comparison is not possible, and the interest of the present specimen demands its separate diagnosis.

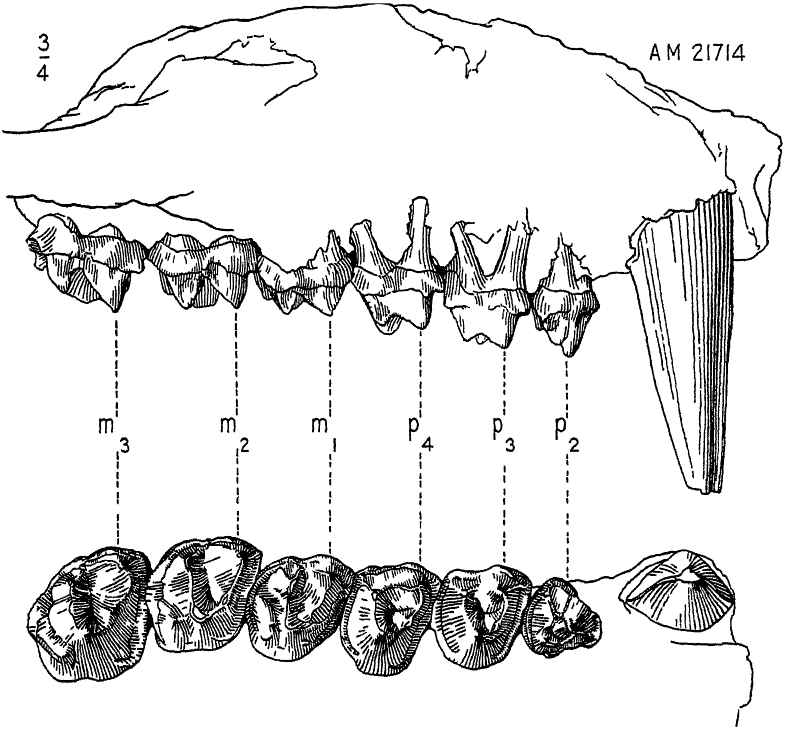

Fig. 7. *Prodinoceras martyr.* new genus and species. Right upper jaw with canine and all cheek teeth, external and crown views. Type. ¾ natural size.

There can be little doubt that this small animal is a creodont, but its affinities within this group are doubtful. The large carnassial M_3 suggests the more primitive members of the Hyænodontidæ, and *Opisthopsalis* may be provisionally placed in this family. Both M_3 and M_1 resemble those of *Sinopa* rather more than any other genus, but *Opisthopsalis* differs from any certain hyænodont in the complication of P_4. This tooth is more nearly, although not exactly, paralleled in the Oxyclænidæ, but that family never shows the carnassial specialization of M_3.

Prodinoceras martyr,[1] new genus and species[2]

TYPE.—Amer. Mus. No. 21714, crushed palate and lower jaws, with upper canines and cheek teeth and heels of M_3, right and left, and of M_2, right.

CHARACTERS.—Canine protruding about 45 mm. from alveolus, nearly straight, tapering evenly to apex, anterior and posterior edges sharp, compressed, external face more convex than internal. P^2 with ectoloph turned inward anteriorly at 45° to tooth row, metacone indicated but not rising free of ectoloph; protocone distinct, lower than metacone, united to paracone by a strong crest and to metacone by a weaker one, enclosing a small basin. P^3 and P^4 similar, the latter larger, distinct metacone and higher paracone, protocone equal to metacone and united to it by a strong, high crest, to paracone by a lower crest with a conule near the protocone, making the crown subquadrate; continuous anterior, external, and posterior cingula, but not continuous across internal base of protocone. M^{1}-^{2} differing from P^{3}-^{4} chiefly in the lower crown, more separate paracone and metacone, and presence of a hypocone directly posterior to the protocone, above the posterior cingulum. M^3 larger, metacone relatively more internal and smaller, anterior and posterior cingula more developed, hypocone more internal, a small cusp posterointernal to it. Talonid of M_3 with high hypoconid, with crest running anterointernally, but heel posterior to this low, posteromedian cusp not elevated. Length P^2-M^3, 102 mm.

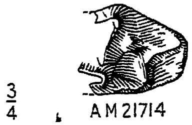

Fig. 8

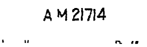

Fig. 9 a

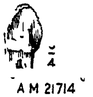

Fig. 9 b

Fig. 8. *Prodinoceras martyr*, new genus and species. Posterior part of right M_3, crown view. Type. ¾ natural size.

Fig. 9. *Prodinoceras martyr*, new genus and species. Isolated incisors associated with type. ¾ natural size.

Prodinoceras is obviously a true uintathere of primitive type, and it is the first indication of this group (as distinct from the coryphodonts) outside of North America.[3] It is very closely comparable with an undescribed genus from the Clark Fork Beds, upper Paleocene, of Wyoming, and like the latter it is an almost ideal ancestral type of uintathere so far as known. It differs, however, from the Clark Fork genus in details of P^2, heel of M_3, and other minor features, which might be interpreted as being very slightly more advanced in the present form and in any event remove it somewhat farther from the later North American genera. As might be expected, the ancestry of the latter is to be sought rather in the Clark Fork form than in that from the Gashato, and although the difference between the two Paleocene genera is slight, *Prodinoceras* appears to be commencing to diverge from the line followed by the American uintatheres.

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[1] Latin, *martyr*, Greek, *μάρτυρ*, testifier—i. e., to the age of the beds and to the presence of true uintatheres in Mongolia.

[2] *Prodinoceras* Matthew, Proc. Zool. Soc. London, 1927 [pub. 1928], pp. 956, 969–970, is the present genus plus that from the Clark Fork, but it was a *genus cœlebs*, and publication dates from the present paper.

[3] *Eudinoceras*, from the Irdin Manha, upper Eocene, of Mongolia, proves to be a coryphodont.

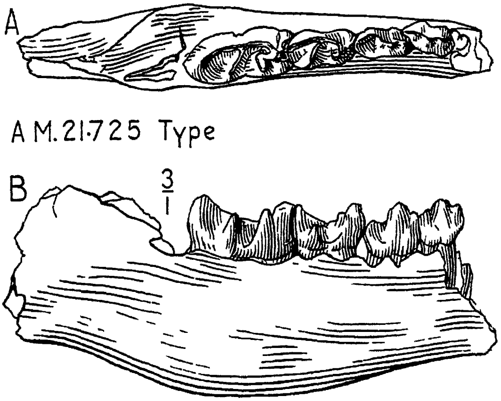


Fig. 10

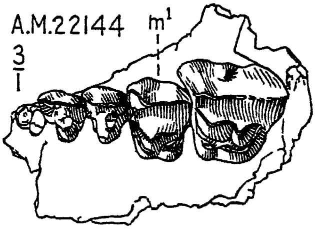


Fig. 11

Fig. 10. *Palæostylops macrodon,* new species. Left lower jaw with P_3-M_2. Type. A, crown view. B, internal view. Three times natural size.

Fig. 11. *Palæostylops macrodon,* new species. Left upper jaw with P^3-M^2, crown view. Paratype. Three times natural size.

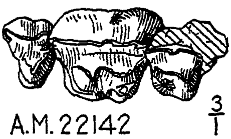
Palæostylops macrodon, new species

TYPE.—Amer. Mus. Nos. 21725, left lower jaw with P_3-M_2.

PARATYPES.—Amer. Mus. No. 20416, right lower jaw with I_3-M_2, somewhat broken. Amer. Mus. No. 22144, left upper jaw with P^3-M^2. Amer. Mus. No. 22142, right upper jaw with M^{2-3} and part of M^1.

DIAGNOSIS.—Cheek tooth series about 20 per cent. longer than in *P. iturus,* molars relatively narrower, $M\frac{2}{2}$ larger relative to other teeth.

In the 1925 collection, *Palæostylops* is very abundant. At least fifty individuals are represented, and they are the most numerous members of the fauna as known. They indicate the presence of a somewhat larger species in addition to the genotype, closely related to the latter but easily distinguished and with intermediate forms absent in the available material. The tooth figured by Matthew and Granger (1925, Fig. 4), as possibly indictating a larger species of *Palæostylops*, does not belong to *P. macrodon*, and its affinities are still uncertain. It does not belong in the upper jaw of this genus.



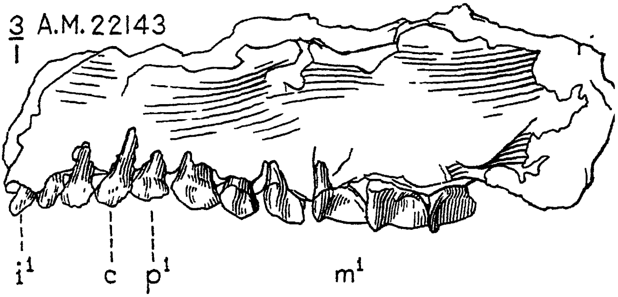


Fig. 12

Fig. 13

Fig. 12. *Palæostylops macrodon*, new species. Right upper jaw with M^{1}-^{3}, somewhat broken, crown view. Paratype. Three times natural size.

Fig. 13. *Palæostylops iturus* Matthew and Granger. Left upper jaw with complete dentition, external view. Referred specimen. Three times natural size.

Palæostylops iturus Matthew and Granger, 1925

The only important gap in previous knowledge of the dentition of this species was due to the absence of I^{1}-C, but these teeth are now clearly displayed in Amer. Mus. No. 22143, a left upper jaw with the complete dentition. The dental formula is $\frac{3.1.4.3.}{3.1.4.3}$. The upper incisors, canine, and premolars form an evenly graded series without any definite morphological breaks. Each of these teeth consists of a simple external wall and an internal heel, sloping and very inconspicuous on I^{1} but progressively stronger until on the posterior premolars it forms a sharp internal cusp. Contrary to the inference from its incomplete alveolus, the canine is not larger than P^{1} and it is hardly to be distinguished in form from this tooth or from I^{3}.

AMERICAN MUSEUM NOVITATES

Number 377
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
Oct. 15, 1929

59.7 (51)

SOME CHINESE FRESH-WATER FISHES[1]

BY J. T. NICHOLS[2]

XIX.—NEW LEUCOGOBIOID GUDGEONS FROM SHANTUNG

With the publication of number XVIII of this series in 1926, it was assumed that most of the obviously new forms of Chinese fresh-water fishes in the collections of the Asiatic Expeditions of The American Museum of Natural History had been reported upon. Considerable attention has since been given to a study of the literature with reference to material already examined. A more critical study of specimens has been resumed only recently in the examination of material obtained at Tsinan, Shantung, in 1924, by a native collector under the direction of Mr. Clifford H. Pope. Herein are found the following forms.

Leucogobio polytænia microbarbus, new subspecies

DESCRIPTION OF TYPE.—No. 9651, American Museum of Natural History, from Tsinan, Shantung, April–June, 1924.

Length to base of caudal, 54 mm. Depth in this length, 3.8; head, 3.4. Eye in head, 3.9; snout, 3.9; interorbital, 3; maxillary, 3.2; depth of peduncle, 2; its length, 1.3; pectoral, 1.6; ventral, 1.8; longest dorsal ray, 1.5; longest anal ray, 1.8; caudal lobe, 1.4. Barbel in eye, 5.

Dorsal, 9; anal, 8. Scales 37–38.

Moderately compressed; head rather blunt; vent a little before anal (about one-fifth the distance to ventral axil); lower parts rounded. Jaws equal; mouth moderately oblique; maxillary not reaching to under front of eye, with a minute subterminal barbel; gill membranes forming a narrow fold across isthmus. No spinous dorsal or anal rays; dorsal origin equidistant from end of snout and base of caudal; ventral origin slightly behind that of dorsal; pectoral rounded, ventral bluntly pointed; pectoral reaching two-thirds the distance to ventral, ventral four-fifths to anal; caudal moderately forked. Scales with close-spaced slightly radiating striæ, weaker than their strong concentric markings; lateral line complete, in the middle of side except for a slight rise in front.

Color much as in *polytænia;* a broad dark central stripe, and narrower stripes above and below it. Dorsal with a dark cross-shade, strongest on the front rays.

This form is obviously very close to *Leucogobio polytænia* from Shansi (Nichols, 1925, Amer. Mus. Novitates, No. 181, p. 6). Its body form tends to be more pointed in front; its decidedly smaller barbel and other slight differences hold in other specimens in this collection, as follows.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 94.

[2] Drawings of type specimens by Gleb Botkin.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Barbel in Eye
61 mm.	3.9	3.6	4	9	8	36	4.5
63	4.1	3.7	3.8	9	8	38	3.5
69	4.2	3.8	4.1	9	8	37	3.5
76	4.1	3.7	4	9	8	36	4
81	4	3.8	4.5	9	8	39	3.8
86	3.9	3.7	4.8	9	8	38	4.5

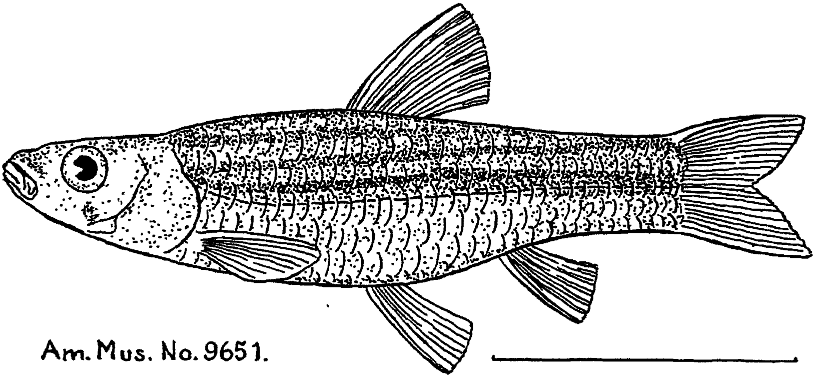
Am. Mus. No. 9651.

Fig. 1. *Leucogobio polytænia microbarbus*, type.

Numerous small specimens seem to represent the young of this form. They have a dark lateral band, not very broad, the only conspicuous color marking. A few of the largest measure as follows.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Barbel in Eye
29 mm.	3.7	3.6	3.5	9	8	37	4
29	3.8	3.4	4	9	8	36	4
30	4	3.3	4	9	8½	38	4
30	4	3.4	4.3	9½	8	36	4
31	4.3	3.5	4	9	8	37	3
31	4.3	3.6	3.7	9½	8	37	4
31	4	3.5	3.8	9	8	36	4
31	4	3.5	4	9	8	36	4
32	4	3.6	4.4	9	8	36	4.5

Gnathopogon intermedius, new species

DESCRIPTION OF TYPE.—No. 9652, American Museum of Natural History, from Tsinan, Shantung, April–July, 1924.

Length to base of caudal, 65 mm. Depth in this length, 3.7; head, 3.6. Eye in head, 3.7; snout, 3; interorbital, 3.2; maxillary, 3.5; depth of caudal peduncle, 2.7; its length, 2; pectoral, 1.6; ventral, 1.6; longest dorsal ray, 1.4; longest anal ray, 1.8; caudal lobe, 1.4. Barbel in eye, 1.8.

Dorsal, 9; anal, 8. Scales, 36.

Moderately compressed; head rather pointed; vent at three-quarters the distance from ventral axil to anal origin; lower parts broadly rounded. Eye very slightly superolateral; lower jaw slightly included; mouth moderately oblique; maxillary not reaching to below front of eye, with a rather small subterminal barbel; gill membranes narrowly joined to the isthmus under edge of preopercle. No spinous dorsal or anal rays; dorsal origin equidistant from end of snout and middle of peduncle; ventral origin under the middle of dorsal base; pectorals and ventrals bluntly pointed; pectoral reaching two-thirds the distance to ventral, ventral three-quarters to anal; caudal moderately forked. Scales with radiating striæ; breast completely scaled; lateral line complete, in middle of side except for a slight rise in front.

A faint dark shade along the middle of side posteriorly; otherwise unmarked, including the fins.

Measurements of several other specimens are given in the following table.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Barbel in Eye
52 mm.	3.5	3.6	3.7	9	8	37 or 38	1.9
53	3.5	3.5	3.7	9	8	35	1.8
53	3.8	3.6	3.5	9	8	38	2.3
54	4	3.4	4	9½	8½	35	1.9
58	3.4	3.4	3.8	9	8	36	1.6
59	3.6	3.4	4	9	8	35	2
61	4	3.8	3.8	9	8	36	2.5
62	3.5	3.5	3.8	9	8	37	1.8
63	3.9	3.6	3.7	9	8	37	2
69	3.4	3.3	4	9	8	36	1.9

The 69 mm. specimen is a female distended with large eggs. In color it has a dark lengthwise shade in the middle of the side and narrower broken stripes above it. It has obscure markings along the lateral line in front suggestive of those most pronounced in *G. wolterstorffi* but also found in other species of this genus; and faint dark marks across the dorsal. It seems to be an abnormal individual, and has the lateral line distinctly bent down in front. The 52 mm. specimen has the lateral line slightly bent down with similar markings.

This form differs from any other examined by the writer and, in view of the number of closely related ones that exist, is probably distinct from *Gnathopogon elongatus* of Japan, though an apparently slightly lower scale count and shorter barbel are poor characters by which to separate it therefrom. It is markedly variable or instable, and also approaches *Leucogobio tæniellus* Nichols (1925, Amer. Mus. Novitates, No. 181, p. 7) from Fukien, being intermediate between these two genera of convenience (*op. cit.*, p. 6). A similar instability is noticeable in certain other fishes in the Tsinan collection and seemingly dependent on the locality. If the cause of this instability could be rightly determined, this would probably be more interesting than solution of the systematic problem. As it is, each of these two problems complicates the other and renders it more difficult.

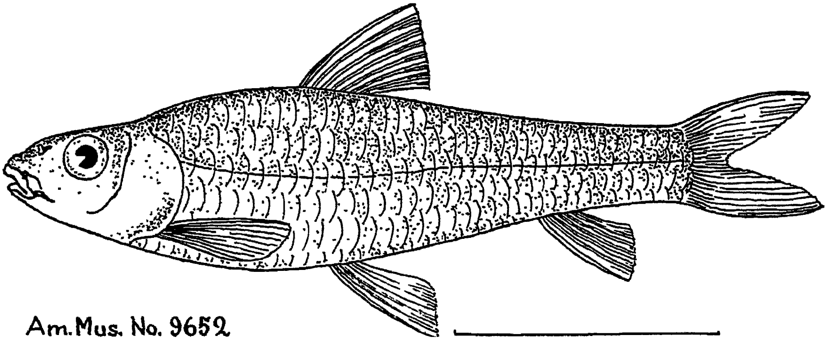

Fig. 2. *Gnathopogon intermedius*, type.

There is a single specimen almost sufficiently like *G. intermedius* to be an aberrant individual of it, but with standard gnathopogon characters pronounced, which at the same time is very close to the geographically distant *G. atromaculatus* Nichols and Pope (1927, Bull. Amer. Mus. Nat. Hist., LIV, p. 351) from Hainan. It has a shorter barbel than that species and may be described as follows.

Gnathopogon similis, new species

Description of Type.—No. 9653, American Museum of Natural History, from Tsinan, Shantung, April–July, 1924.

Length to base of caudal, 58 mm. Depth in this length, 4.5; head, 3.7. Eye in head, 3; snout, 3; interorbital, 3.4; maxillary, 3.6; barbel, 4; width of body at shoulder, 2; depth of peduncle, 2.6; its length, 1.5; pectoral, 1.4; ventral, 1.4; longest dorsal ray, 1.3; longest anal ray, 1.9; caudal lobe, 1.1.

Dorsal, 9; anal, 8. Scales, 37 to 38.

Moderately compressed; breast and belly rounded; vent at three-eighths the distance from anal origin to ventral axil Interorbital slightly concave; eye large, oval, slightly superolateral, maxillary slightly oblique, not reaching to under front of eye; lower jaw without free lip, distinctly included; gill membranes narrowly joined to isthmus slightly behind margin of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from end of snout and middle of last anal ray; ventral origin under middle of dorsal base; pectoral reaching four-fifths the distance to ventral, ventral three-quarters to anal; caudal well forked, with narrow pointed lobes Scales thin; body completely scaled; lateral line complete, dipping slightly in front, in the center of peduncle

Color pale; a small dark spot on dorsal origin; a rather obscure dark stripe in center of peduncle, rising above lateral line over ventral; a faint dark stripe behind the vent, and dark mark at base of each caudal lobe; faint specking along lateral line suggesting *wolterstorffi*. Lower half of opercle bright, with a dark dot above

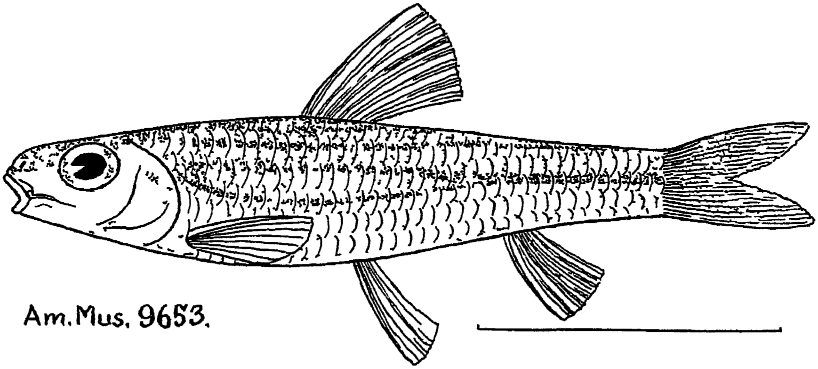

Fig 3. *Gnathopogon similis*, type

Other gudgeons abundantly represented in the Tsinan collection are *Pseudogobio rivularis* (Basilewski) and *Pseudogobio chinssuensis* Nichols, the last up to 43 mm. standard length A *Sarcocheilichthys*, subgenus (*Chilogobio*), is also plentiful, identified as *S nigripinnis sciistius* (Abbott).

XX—AN UNDESCRIBED FORM OF *RHODEUS* FROM SHANTUNG

A considerable series of *Rhodeus* from Tsinan shows a tendency to deviate from the standard characters of *Rhodeus sinensis* Gunther, but a great majority are clearly referable to that species, with a somewhat lower fin-ray count than is usual, dorsal branched rays 7 to 9, anal 8 to 9, in most cases 8 in the dorsal and 9 in the anal. This species ordinarily has 9 or 10 dorsal and 8 to 11 anal branched rays.

This tendency to few fin-rays is parallelled in a small series (9) of related *Pseudoperilampus ocellatus* Kner from the same locality, with dorsal branched rays 10 to 11 (in most cases 11), anal 9 to 11 (in most cases 10), instead of being about 12 in both fins.

Occurring with the material referred to *Rhodeus sinensis* above, a number of small specimens are at once differentiable by being more slender, the black rhodein stripe bolder and carried forward to the head in a broader dusky shade from dark scale outlines. Closer examination shows that these have simple dorsal and anal rays more spinous, frequently rather well-developed spines with soft tips, and a ray or two more in the dorsal. Though this last character is normal for *sinensis* it helps to differentiate them from the particular *sinensis* with which they are associated, and the combination of characters seems to require their recognition as a new form. Though possibly an ecological subspecies, this is certainly not a geographic subspecies and is described as follows.

Rhodeus notatus, new species

Description of Type.—No. 9654, American Museum of Natural History, from Tsinan, Shantung, April–July, 1924, male.

Length to base of caudal, 33 mm. Depth in this length, 2.8; head, 4.4. Eye in head, 2.7; snout, 3.4; interorbital, 2.7; maxillary, 3.6; width of body, 2; depth of peduncle, 2.1; its length, 1.1; pectoral, 1.2; ventral, 1.4; longest dorsal ray, 1.2; longest anal ray, 1.4; caudal lobe, 0.9.

Dorsal, II, 9½; anal II, 9½. Scales 32 to 33.

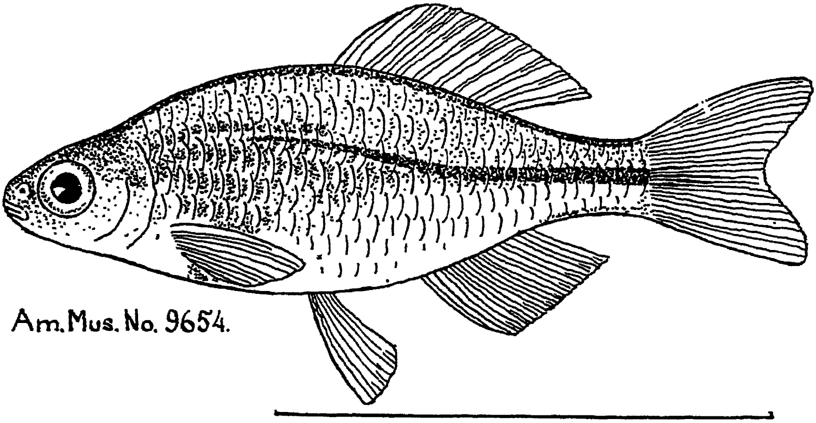
Am.Mus. No. 9654.

Fig. 4. *Rhodeus notatus*, type.

Body compressed; its outlines evenly convex and the nape not appreciably elevated; vent at about five-eighths the distance from anal origin to ventral axil. Top of head slightly convex; mouth distinctly inferior, maxillary not quite reaching to under front of eye; gill-membranes attached to isthmus under middle of preopercle. Last simple dorsal and anal rays weakly spinous almost throughout with soft tips. Dorsal origin equidistant from base of caudal and middle of snout, immediately behind base of ventrals; anal origin under middle of dorsal base; pectoral reaching about to ventral origin, ventral about to that of anal; caudal well forked. Scales with only faint concentric striæ noticeable: lateral line on first five scales.

A bold dark stripe in center of peduncle, continued backward with a narrow break in a dark mark on the middle caudal rays; forward this stripe bends upward, becomes narrower, and is appreciable almost to the head. An obscure dark blotch behind the upper angle of the gill cleft, dark stripe on the snout, and dark shade on the upper part of gill-cover, below which last there is a bright area. Scales on sides anteriorly with dark more or less vertical marks at their borders; breast and belly before the anal dark. Dorsal, anal and ventral fins dusky; the anterior dorsal rays pale distally; the anal pale submarginally, very narrowly black-tipped.

Measurements of additional specimens follow. The fin-count includes 2 simple more or less spinous rays in dorsal and anal.

The females have a black spot on the front of the dorsal fin; only one of the males has such a spot faintly indicated.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Sex
23 mm.	2.6	3.9	2.7	11½	11	31	Male
26	2.9	4	2.7	12	11	32	Male
27	2.8	4	2.7	12	11	33	Male
27	2.6	4.1	2.6	11	11	32	Female
28	2.7	3.9	2.6	11	11	34	Female
30	2.7	3.9	2.9	11	10	32	Female
30	2.8	4	2.7	11	11	33	Male
30	2.9	4	2.7	11	11	About 30	Female

XXI. AN ANALYSIS OF MINNOWS OF THE GENUS *PSEUDORASBORA* FROM SHANTUNG

'In 1925[1] and 1928[2] the writer recognized 5 species of *Pseudorasbora* from China, instead of referring Chinese material to one widely distributed form in eastern Asia with type locality Japan. Rendahl (1928)[3] discredits this analysis as being based on slight variable characters and inadequate material. The material on which the writer's opinion was based, however, was not so inadequate as one might have been led to suppose. It indicates clearly enough that the variable fish widely known as *Pseudorasbora parva* occurs in several forms, recognizable though hard to define, which are more or less geographic and something more than individual variation. That they are sufficiently well marked to make their taxonomic recognition desirable is, on the other hand, not at all sure, and it will be best for the present to consider them subspecies of *P. parva.*

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[1] Nichols, 1925, Amer. Mus. Novitates, No. 182, pp. 4–6.
[2] Nichols, 1928, Bull. Amer Mus. Nat. Hist., LVIII, pp. 19–20, Figs. 8–10.
[3] Rendahl, 1928, Arkiv. for Zool., 20A, No. 1, pp. 103–107.

Examination of a considerable series of *Pseudorasbora* in the Tsinan, Shantung collection, complicates the problem in that there seem to be from this one locality three distinct forms, not at all difficult to pick out from a mixed lot of specimens. The great majority belong to a small short-bodied, broad-headed form, with more than usually heavily pigmented scales, which may be described as *Pseudorasbora parva parvula,* new subspecies.

Pseudorasbora parva parvula, new subspecies

Description of Type.—No. 9655, American Museum of Natural History, from Tsinan, Shantung, April–July, 1924.

Length to base of caudal, 55 mm Depth in this length, 3.5, head, 3.9. Eye in head, 4.5; snout, 3.5; interorbital 2; maxillary, 4; width of body, 1.7; depth of peduncle, 1.7, its length, 1.3, pectoral, 1.5, ventral, 1.5, longest dorsal ray, 1.2; longest anal ray, 1.8, caudal, 1.1.

Dorsal, 9, anal, 8. Scales, 35.

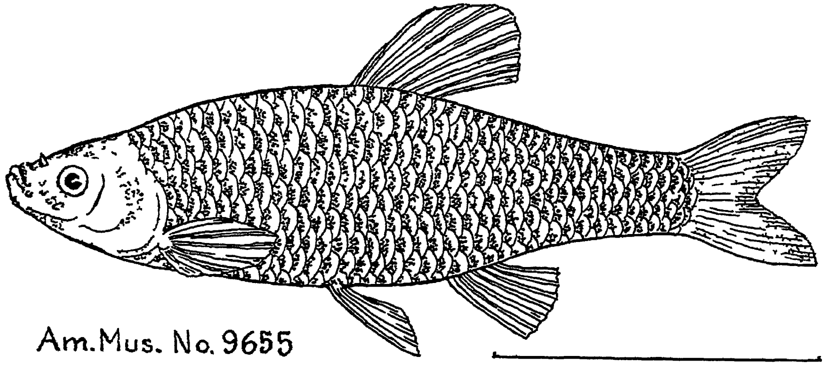

Fig 5. *Pseudorasbora parva parvula,* type.

Body compressed; interorbital broad, very slightly convex; nape slightly elevated Mouth small, transverse, almost vertical, lower jaw slightly projecting; maxillary not reaching half the distance to eye, no barbels, opercle with a membranous edge; gill membranes joined to breast slightly before middle of opercle; 2 pairs of horny warts on the chin, a row from maxillary back under eye. Dorsal and anal without spinous rays; dorsal origin equidistant from tip of snout and base of caudal, over ventral base; pectoral extending two-thirds the distance to ventral, ventral four-fifths to anal; caudal moderately forked; all fins rounded or bluntly pointed. Scales with inconspicuous radiating striæ; lateral line complete, dropping slightly behind opercle, thence straight to caudal base in center of side

A little darker colored above than below. Central part of each scale dusky. Fins dusky or grayish.

A representative series of specimens measure as follows.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Inter-orbital	Longest Dorsal Ray
49 mm.	3.6	3 9	3.8	9	8	37	2.4	1.4
51	3.5	3.8	4	9	8	36	2.4	1.4
53	3.8	3.8	4.3	9	8½	36	2.1	1.2
53	3.7	3.8	4	9	8	37	2.1	1.6
54	3.6	4	4.6	9	8	37	2	1.4
55	3.9	3.9	4	9	8	36	2	1.4
56	3.6	4	4.2	9	8	37	2.1	1.3
57	3.5	3.9	3.9	9	8	37	2.1	1.2
59	3.5	4	4	9	8	37	2	1.4
73	3.4	4.2	4.5	9½	8	35	1.8	1.3

At a standard length of 50 to 55 mm. this form frequently has horny warts on the face which are relatively somewhat larger, especially those under the eye, than such warts in the following form at 65 to 70 mm. standard length.

Pseudorasbora parva fowleri, (Nichols)

The second form of *Pseudorasbora,* of which a number of specimens are present in the Tsinan collection, seems to be the same as is common in the lower Yangtze Valley. It is usually paler than *parvula,* but sometimes equally dark, so that color is not a good criterion to separate it. The best character seems to be a narrower interorbital in the same-sized *fowleri.* The interorbital gets broader with age, so that there is considerable overlap if the size of the specimen is not taken into consideration. For purposes of comparison, a few Tsinan specimens of *fowleri* measure as follows.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Inter-orbital	Longest Dorsal Ray
55 mm.	4.1	3.6	3.8	9	8	35	2.5	1.3
55	3.8	3.5	3.7	9	8	34	2.6	1.4
57	4	3.7	3.8	9	8	35	2.5	1.3
58	3.8	3.8	3.7	9	8	35	2.5	1.3
65	3.8	4.2	3.8	9	8	34	2.3	1.4

Pseudorasbora parva parva from Japan (not seen by the writer) seems to be very close to *fowleri* but with a higher scale count, and probably does not occur in China if these other subspecies be recognized.

Pseudorasbora parva tenuis, new subspecies

The third form of *Pseudorasbora* in this collection is represented by several small specimens readily picked out from a considerable lot of *parvula*, and which also seem different from the young of *fowleri*, to which three or four other specimens in the same lot are referred. They are slender, large-eyed, interorbital broad, much as in *parvula*, dorsal high; and have a narrow black lengthwise stripe more or less developed. A practically identical color marking may, however, be present in the other forms. This would seem to be an ecological rather than a geographic subspecies.

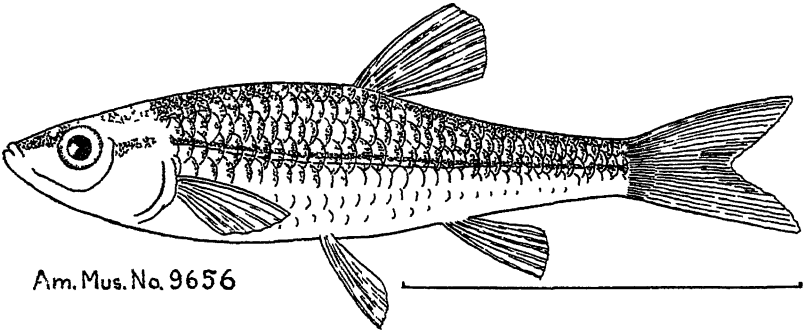

Fig. 6. *Pseudorasbora parva tenuis*, type.

Description of Type.—No. 9656, American Museum of Natural History, from Tsinan, Shantung, summer of 1924.

Length to base of caudal, 41 mm. Depth in this length, 4.3; head, 3.8. Eye in head, 3.3; snout, 3; interorbital, 2.4; maxillary, 4; width of body, 2.2; depth of peduncle, 2.6; its length, 1.3; pectoral, 1.5; ventral, 1.5; longest dorsal ray, 1.1; longest anal ray, 1.6; caudal lobe, 0.9.

Dorsal, 9; anal, 8. Scales 34.

Nape very slightly elevated; snout pointed; mouth oblique; lower jaw slightly projecting; maxillary extending half the distance to under front of eye; gill membranes narrowly joined to breast well behind margin of preopercle. Dorsal and anal without spinous rays; dorsal origin equidistant from end of snout and base of caudal, over ventral base; pectoral reaching three-quarters the distance to ventral, ventral three-quarters to anal; caudal well forked. Scales with well-marked slightly radiating striæ; lateral line complete in middle of side, rising slightly at shoulder.

Color darker along the back and paler below; a blackish streak from before eye to base of caudal.

Additional specimens measure as follows.

Standard Length	Depth	Head	Eye	Dorsal	Anal	Scales	Inter-orbital	Longest Dorsal Ray
31 mm.	4.5	3.7	3	9	8	35	2.4	1.2
32	4.5	3.6	3	9	8	33	2.3	1.1
36	4.5	3.9	3	9	8	33	2.4	1.1
37	4	3.7	3	9	8	35	2.4	1.2
40	4.3	4.1	3	9	8	?34	2.3	1.1
40	4.3	3.7	3	9½	8	35	2.4	1.2

AMERICAN MUSEUM NOVITATES

Number 378 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Oct. 15, 1929

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THE GENUS *MYXOSARGUS* BRAUER (STRATIOMYIDÆ, DIPTERA)

BY. C. H. CURRAN

There are four previously described species belonging to this genus, three of them originally described from Mexico, the other from Brazil. In 1914, Enderlein presented a key for the separation of the species but, since he used the color of the scutellum as a means of separating the species, it is impossible to follow him. In all of the males that I have seen, the scutellum is blackish with yellow spines; in the females, with the exception of *braueri* Williston, the scutellum is yellowish, at most the very narrow base being black. The only species described from both sexes is *fasciatus* Brauer, the type of the genus, and apparently the males of the two species described by Williston are unknown. For this reason it is impossible to present a key which will satisfactorily separate all of the species. References to the original descriptions are given in connection with the species.

MYXOSARGUS Brauer

BRAUER, 1881, Denkschr. Akad. Wissen. Wien, XLIV, p. 77.
ENDERLEIN, 1914, Zool. Anzeiger, XLIII, p. 612.

KEY TO SPECIES

1. Posterior four femora broadly yellow at base.......... *scutellatus* Williston.
Posterior femora black on basal half or more.......... 2.
2. Basal two antennal segments reddish or brownish yellow.......... 3.
Antennæ wholly deep black.......... *knowltoni*, n. sp.
3. Males.......... 4.
Females.......... 6.
4. Front black with two chalk-white marks at base of antennæ .. *fasciatus* Brauer.
Front at most obscurely reddish at base of antennæ.......... 5.
5. Basal half of wing hyaline; pile of thorax grayish white.. *grypus* Enderlein.
Anal cell strongly clouded with brown; middle of mesonotum with yellowish pile.......... *panamensis*, n. sp.
6. Front with a median and two lateral tubercles.......... *fasciatus* Brauer.
Front with only one tubercle.......... 7.
7. Scutellum black with yellow border.......... *braueri* Williston.
Scutellum yellow.......... 8.
8. Frontal tubercle geminate, longitudinally divided, knobs of halteres yellow. *panamensis*, n. sp.
Frontal tubercle not divided, rather small; knobs of halteres brown. *texensis*, n. sp.

Myxosargus knowltoni, new species

At once distinguished from all the described species by the wholly deep black antennæ. Length, 5 mm.

MALE.—Head metallic greenish black, black-haired, the cheeks with pale yellowish hair. The wholly black antennæ are situated on the prominent rounded tubercle formed by the face and front, the anterior oral margin not conspicuously produced downward and situated only slightly more forward than the upper angle of the frontal triangle.

Thorax black, with more or less metallic-green reflections, the mesonotum metallic green. Scutellum with yellow apex and short yellow spines. Pile yellowish, on the broad sides of the mesonotum and on the mesopleura, black. Knobs of halteres yellow.

Legs black; apices of the posterior four tibiæ reddish, the basal two segments of the posterior four tarsi yellow; anterior femora broadly, the middle pair narrowly reddish yellow at the apex.

Wings cinereous hyaline; the first brown band does not extend backward beyond the anterior margin of the discal cell; second band extending from the apex of the third vein to the second posterior vein, the marginal cell hyaline or only tinged with yellow.

Abdomen black, its dorsum black-haired, the sides with long black pile; venter with short, yellowish pile.

FEMALE.—Pile of head whitish, short, only the lower part of the face with black pile; front without a tubercle, with a silvery triangular spot at either side touching the depression. Pile of thorax whitish and short, the mesonotum with traces of four bronzed vittæ; scutellum yellow with the narrow base black. Middle tarsi with the basal three segments yellowish. Abdominal pile short, whitish on the sides and venter.

TYPES.—Holotype, ♂, Clearfield, Utah, July 12, 1927. Allotype, ♀, Brigham, Utah, July 19, 1927, resting on beets. Donated to the American Museum by the collector, Mr. G. H. Knowlton.

In this species the face and front are much more produced than in any of the others. It seems probable that this is the species recorded from Georgia by von Roeder and considered by him to be a variety of *fasciatus*.

Myxosargus scutellatus Williston

WILLISTON, 1901, 'Biol. Centr. Amer.,' Dipt., I., p. 251.

Originally described from two females from Mexico and not since recorded. The yellow bases of the posterior four femora will serve as a ready means of identification.

Myxosargus fasciatus Brauer

BRAUER, 1882, Denkschr. Akad. Wien., LXIV, p. 78.
GIGLIO-TOS, 1901, Mem. Acad. Sci. Nat. Torino, XLIII, p. 109.
WILLISTON, 1901, 'Biol. Centr. Amer.,' Dipt., I, p. 251.

An easily recognized species in both sexes: the male has two milky white spots on the front near the antennæ while the female has lateral frontal tubercles in addition to the median one. The scutellum is evidently black in the female.

Described from Mexico and subsequently recorded from Texas, Georgia and North Carolina. Records from these last three localities evidently refer to other species.

Myxosargus grypus Enderlein

ENDERLEIN, 1914, Zool. Anzeig., XLIII, p. 612.

This species is evidently closely related to the following species. The description is drawn from a single male which differs from *panamensis* in having the basal half of the wing hyaline and grayish white pile on the mesonotum. The female will no doubt be found to have a yellow scutellum.

Recorded from southern Mexico.

Myxosargus panamensis, new species

Legs black, in part reddish and yellow; female with yellow scutellum; anal cell brownish gray. Length, 5.5 to 6 mm.

MALE.—Head black with slight metallic reflection; pile white, black only on the quite strongly developed snout. Antennæ with the basal two segments and usually the base of the third below, yellowish or luteous.

Thorax greenish black, the lateral third of the mesonotum and narrow sides of the scutellum of a grayish-green shade, rather metallic; pile whitish, on the median third of the mesonotum and the whole of the scutellum, pale brassy yellow. Narrow lower border of scutellum, except basally, and the long spines, pale yellowish.

Legs black; apical third of the anterior femora, apical fifth or less of the middle pair, narrow base of the middle tibiæ, usually the broad base of the posterior tibiæ dorsally and often the broad apex of the anterior tibiæ, reddish. On the anterior tibiæ the reddish color is usually obscure in the males. Apical half of middle tibiæ, the first four segments of their tarsi and the basal two of the posterior tarsi, reddish yellow, the fourth segment of the middle tarsi brown above; apical segments of the posterior four tarsi brown.

Wings grayish with the anterior basal half and the preapical fascia hyaline, the usual fasciæ and anal cell brownish or at least considerably darker than elsewhere. Knob of halteres greenish.

Abdomen black, black pilose dorsally, the broad sides and venter with yellowish tinged pile.

FEMALE.—Front with a geminate median tubercle; pile of thorax and abdomen shorter; silvery spots at either end of the frontal depression small; anterior tibiæ often more or less reddish basally and always broadly reddish at the apex, the posterior tibiæ reddish on the apical third.

TYPES.—Holotype, ♂, Barro Colorado Island, December 27, 1928. Allotype, ♀, Barro Colorado Island, February 18, 1929. Paratypes: three males, Panama

City, December 28, 1928; four males and three females, Barro Colorado Island, December 21, 25, 27, 28, 1928 and January 10 and 28, 1929; male, Fort Davis, February 9, 1928; male and five females, Corozal, January 16, 22 and February 4, 1929 (C. H. Curran). All of these localities, except Panama City, are in the Canal Zone.

Myxosargus texensis, new species

First segment of anterior tarsi yellow on posterior surface. Length, 6 mm.

FEMALE.—Head shining black, short white pilose, the downwardly produced "beak" with brown hair which becomes black at the apex; frontal tubercle small, silvery spots at sides of frontal depression sub-rectangular. Basal two antennal segments yellowish brown or luteous, the apical segment brown.

Thorax greenish black, in some lights with a pair of broad, narrowly separated pale vittæ which may appear somewhat bronzed in other lights. Pile whitish, short. Scutellum pale yellow with the base narrowly black.

Coxæ and femora black, apical third of anterior femora yellowish, apex of middle femora more or less broadly, reddish; all the tibiæ with the base reddish and the apical half yellow; first segment of anterior tarsi yellow posteriorly, the basal three segments of the posterior four pairs and the under surface of the fourth segment of the middle tarsi, yellow.

Wings cinereous hyaline, with the usual brownish crossbands; knobs of halteres brown.

Abdomen brownish black, black-haired dorsally, the broad sides and venter with short whitish hair.

TYPES.—Holotype, ♀, Austin, Texas. Paratype, ♀, same data. The specimens are from the Wheeler collection.

Myxosargus braueri Williston

WILLISTON, 1888, Trans Amer. Ent. Soc., XV, p. 254.

This species is represented by three type specimens from Corumba. It is quite easily recognized in the female on account of the black scutellum and single frontal tubercle. The male has not been described.

Originally described from Brazil.

AMERICAN MUSEUM NOVITATES

Number 379 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Oct. 17, 1929

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STUDIES FROM THE DWIGHT COLLECTION OF GUATEMALA BIRDS. I

BY LUDLOW GRISCOM

Just one week before his death, Dr. Jonathan Dwight asked me to study and report upon the unrivalled collection of Guatemalan birds made by A. W. Anthony during the past five years, totalling nearly 8000 specimens from every section of the country, except Peten. Originally we had planned to do this jointly, but long illness prevented him from ever making a start. His collection has now passed to The American Museum of Natural History, the authorities of which have authorized me to carry out his wishes and prepare the extensive report involved. Long interested in Central American birds, I greatly appreciate the privilege of studying so valuable a collection, but I cannot refrain from regretting the loss of Dr. Dwight's companionship in this undertaking and the value of the experienced and conservative judgment of one who was friend and mentor ever since my boyhood.

Guatemala is an exceedingly diversified country, but almost no adequately labelled modern material existed, until the present collection was formed. Eighty years ago thousands of trade-skins were shipped to Europe, and about 1870, after Salvin's exploring trips, more was known about the bird-life of Guatemala than any other portion of Central America. Most of these specimens have no locality labels, though we know that the majority came from Alta Vera Paz, and the city of Coban was the distributing center. Salvin's personal collection was thoroughly labelled, but he was never interested in racial variations, nor has his material in the British Museum ever been restudied. Certainly the great majority of Guatemala specimens in American museums are old trade-skins of characteristic make, and they prove to be quite useless for subspecific comparison.

It is no wonder, then, that large and uniform series from many sections of the country not only alter in many cases our concepts of long-established species and races, but also show the existence of hitherto unrecognized forms either in Guatemala itself, or in adjoining areas, when the typical form is found in Guatemala. It seems advisable to present some of these conclusions at once in a series of preliminary studies, so that they can have the benefit of criticism prior to the appearance of the final report. Whenever possible, types have been selected from the Dwight Collection. All measurements are in millimeters, and technical color-terms follow Ridgway's nomenclature.

THE STATUS OF *Colinus hypoleucus* (Gould)

The more quails from Mexico and Central America that are secured, the more remarkable and difficult to interpret become their variations. In Mexico, melanism and erythrism of the underparts occur in almost every conceivable pattern and combination, and apparently are constant in relatively small areas. With this group we are not here concerned. Farther south, in Central America proper, another group of species occurs, with slightly crested heads, a structural character affording a transition to the well-crested species *leucopogon* and its races of Panama and northern South America. I am not, therefore, impressed with the value of maintaining the genus *Eupsychortyx*.

These three Central American species are *nigrogularis*, *hypoleucus* and *leylandi*. At first sight the males are strikingly distinct, but the great similarity of the females may perhaps indicate a closer genetic relationship than the outward differences of the males. Two of these species are well represented in museums and well known, but *C. hypoleucus* is a rare and little-known bird, and I doubt if a good series has ever been brought together in this country.

The most casual glance at an adult male of *hypoleucus* shows that it is *C. leylandi* with the forehead, superciliaries and most of the underparts white. A glance at the four adult males before me shows that no two are alike. One has practically no white superciliary stripe, a second has brown feathers appearing here and there over the entire underparts, a third has a narrow vinaceous breast-band, and the fourth has underparts like *leylandi* with a white throat, and white feathers appearing here and there elsewhere. It is obvious, therefore, that the white on the underparts of *hypoleucus* is nothing but partial albinism, so far as we know always present, but varying greatly in extent.

The females, however, prove this point even more satisfactorily. Two of them are exactly like *leylandi*, but average a grayer brown throughout, as indeed do the males, and the throat is less streaked. One has a scattering of white feathers on the chest, but a particularly buffy throat and superciliaries. The fourth has white superciliaries and a white throat.

To complete this review, I call attention to the fact that in *C. leucopogon* of Panama the white forehead and superciliaries reappear as a definite and fixed character in males, and a white throat as a "phase" in females. In general color, however, the female of *C. hypoleucus* is practically indistinguishable from the female of *C. leucopogon leucotis.*

How, then, are we to interpret these facts in nomenclature? Is *hypoleucus* a distinct species, a race of *leylandi,* or a mere case of albinism, deserving no nomenclatural recognition? Of these alternatives I prefer the middle course. The third course would be tenable only if typical *leylandi* should turn up in Guatemala and albinistic specimens be found from Honduras southward. Even if they did, and this point were finally disposed of, the Guatemalan bird would be a distinct subspecies, as a paler, grayer brown bird, and the female with greatly reduced streaking on the throat. This race would have to be called *hypoleucus,* though the characters were quite different from those originally ascribed. The name *hypoleucus* can never disappear, therefore, no matter what we may find out about albinism in these quail in the future.

I admit that I can advance no sound biological reason for not regarding *hypoleucus* as a distinct species. I am influenced probably solely by my systematic training. As I look at the male with almost no albinism and the two females with none, I cannot regard them as specifically distinct. A similar step has already been taken by Bangs and Peters (1928, Bull. Mus. Comp. Zool., LXVIII, No. 8, p. 386) who regard the majority at least of the Mexican quail as races of *C. virginianus,* and I thoroughly agree that this change in nomenclatural treatment more nearly approximates the underlying biological facts. A further extreme could be urged, and the specific distinctness of even *leucopogon* could be questioned. But here the great development of the crest is a definite structural character, regardless of the parallelism of certain color patterns, and this fact can best be recognized in nomenclature by treating *leucopogon* as a distinct species.

So far as known, this quail is found only in the drier parts of the interior at moderate altitudes, and seems to be uncommon or rare, in marked contrast to the abundance of *leylandi* farther south.

Chæmepelia minuta interrupta, new subspecies

SUBSPECIFIC CHARACTERS.—Nearest to *Chæmepelia m. elæodes* Todd of southwestern Costa Rica and Panama, but both sexes grayer, less brown above; strikingly distinct below, the adult male grayer, less vinaceous, the female even more distinct than the male, hair-brown rather than warm drab, both sexes with the chin whiter, and the white area more extensive.

TYPE.—No. 62,270, Dwight Collection; ♀ ad.; Secanquim, Guatemala; March 15, 1926; A. W. Anthony.

SPECIMENS EXAMINED

Chæmepelia minuta elæodes.—S. W. Costa Rica, 6 ♂, 10 ♀, 3 immature. Pearl Islands, 4 ♂, 1 ♀.

Chæmepelia minuta interrupta.—Guatemala: Secanquim, 1 ♂, 1 ♀; Chimoxan, 2 ♂, 1 ♀; Finca Chama, 1 ♂; Chipoc, 1 ♀. British Honduras: Belize, 1 ♂; Toledo District, 1 ♀; Manatee District, 1 ♀.

There is no longer the slightest question that this ground dove has an interrupted distribution in Central America, and is absent, from most of the country at least, between Guatemala and southwestern Costa Rica. In Guatemala it seems to be a rare and local bird, and the series listed above is probably the first of its kind to become available. When Todd wrote his monograph of *Chæmepelia* he had only two specimens from Guatemala, and one only that was recently prepared. With a series available, we have a strongly marked form, which needs no further comment. The disposition of the three British Honduras specimens is uncertain. The single male is old and of no comparative value, though nearer the Guatemalan males. The two females are, however, quite different from both the Guatemalan and Costa Rican series and, in fact, are intermediate, though slightly nearer the former. As these birds are apparently disconnected from the range of the Guatemala race by wide stretches of tropical rainforest, in which this dove does not occur, I hazard the guess that an adequate series will show them to be separable also.

Oreopeleia albifacies anthonyi, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to typical *O. albifacies* of Vera Cruz, but occiput and nape brownish instead of gull-gray; forehead more buffy, less white; foreneck and chest obviously browner, lacking the suffusion of buffy gray, so characteristic of *albifacies.*

TYPE.—Dwight Coll., Amer. Mus. Nat. Hist.; ♀ ad.; San Lucas (=Toliman), Guatemala; January 8, 1928; A. W. Anthony.

SPECIMENS EXAMINED

Oreopeleia a. albifacies.—Vera Cruz, 5.

Oreopeleia a. anthonyi.—Guatemala, 2.

Oreopeleia a. silvestris.—Nicaragua, 2.

Salvadori, Salvin and Godman, and Ridgway have all commented on the variation in this species, and the last mentioned the probable expediency of further subdivision. One difficulty has always been that the obvious differences between Guatemalan and Mexican birds, as regards the occiput, were apparently bridged by the Nicaraguan. Mr. Ridgway was also, perhaps, misled in thinking that the sexes were alike. This is not quite the case, the female tending to be a little more dully colored, the occiput more extensively brown, and the foreneck and chest browner, less gray. Thus, the female of *silvestris* Dickey and Van Rossem is very close indeed to the highly plumaged male from Mexico; so much so, that the late Waldron deW. Miller and I, some years ago, when comparing twelve birds from Nicaragua with some old Mexican specimens, without having any Guatemalan birds available, completely overlooked the differences between them.

It by no means follows that all Guatemalan records are *anthonyi.* Most of the specimens are in Europe, and I have seen none from the highlands of Vera Paz and Coban, from which source come some of the old trade-skins in American museums. It is possible that these may well belong to typical *albifacies.* This ground dove is exclusively a cloud-forest species, and is almost never found below 3500 feet.

Podilymbus gigas, new species

SPECIFIC CHARACTERS.—Nearly twice as large a bird as the North American *Podilymbus podiceps,* with a very deep culmen; heavy, powerful legs and feet, and a remarkably short wing; coloration generally darker; no buffy in breeding plumage; head, neck and throat black except for dark grayish auriculars and a narrow half-collar of grayish brown on foreneck; no whitish border to black throat patch; nape and sides of neck with a dark bottle-green gloss; chest blackish, flecked with silvery white; underparts much darker, the black spotting much heavier, especially on sides, flanks, belly and under tail-coverts; underparts a darker blackish brown. The three specimens show the usual variation in respect to the lighter edgings to feathers of the throat and head.

TYPE.—No. 62,904, Dwight Collection; ♀ ad.; Panajachel, 5300 ft., north shore of Lake Atitlan, Guatemala; October 2, 1926; A. W. Anthony.

MEASUREMENTS

	gigas	*podiceps*
Wing	123–131	116–126.5 mm.
Culmen	22– 23.5	19– 20
Depth of bill	15– 16	11– 11.5
Middle toe	62– 65.5	50– 53

This curious pied-billed grebe is confined to Lake Atitlan, where it was first collected by Salvin, who commented on some of its peculiarities. It so happened that Ogilvie-Grant wrote up the grebes for the 'British Museum Catalogue' before Salvin and Godman got around to studying this family for the 'Biologia.' Grant concluded that the differences of the Atitlan bird were due to age (!), and Godman followed him, Salvin having died in the meantime.

Pionus senilis decoloratus, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to typical *Pionus senilis* (Spix), but throat and chest noticeably more dusky purplish, less blue; abdomen and sides of vent oil-green, less bright green; primaries averaging more extensively bright blue, especially on the inner webs, passing less rapidly to green terminally, often tinged with blue throughout, whereas in typical *senilis* the terminal inch of the wing is always markedly green even in highly plumaged males, and the inner webs of the outer primaries have a green strip between the blue and the dusky.

TYPE.—No. 116,545, Mus. Comp. Zoöl.; ♂ ad.; Pozo Azul de Pirris, southwestern Costa Rica; June 12, 1903; C. F. Underwood.

SPECIMENS EXAMINED

Pionus s. senilis.—Guatemala: Finca La Primavera, 1 ♂, 1 ♀; La Montañita, 2 ♀; Chipoc, 1 ♀; near Quirigua, 1 ♂.

Pionus s. decoloratus.—Large series from southern Quintana Roo, British Honduras and Honduras to western Panama.

Specimens from the northern part of the range of this species have been extremely rare in American collections, and the present series shows that there are marked color differences between the geographic extremes. Spix gave no locality, but his description and plate apply better to the northern bird, and in his day Mexico or Guatemala was a far more probable source of origin for his specimen than any part of the southern range of this species. Moreover, Hellmayr states that the type is identical with specimens from Mexico and Guatemala. I, therefore, designate Vera Cruz, Mexico, as the type-locality of true *senilis* and describe the southern extreme.

In the large series of the southern form examined from every part of its range, specimens from southeastern Nicaragua, Costa Rica, and Almirante, Panama, are typical. Specimens from southern Quintana Roo, British Honduras, Honduras, and northern Nicaragua are intermediate but nearer the southern form. The characters given are, of course, best marked in adult males. They are much less marked in adult females and younger males, and I am quite unable to distinguish the immature.

Nyctidromus Albicollis IN MEXICO AND CENTRAL AMERICA

The races of the parauque in Mexico and Central America have been in some confusion for years, due to the absence of adequate series of true *albicollis* from Guiana, and the minute responses of this plastic bird to various differences in its environment. Having examined over 500 specimens from north of Panama, including 200 from Guatemala northward, it may be helpful to give some general comments on this material. In southern Texas and northeast Mexico we have a pale and very large bird (wing 175–187), *merrilli* Sennett. As we proceed southward, the bird gets smaller and darker. The darkest birds are found in southern Vera Cruz and Tabasco, and a large series from Alta Vera Paz, Guatemala, are absolutely identical. Only about 40 per cent of the specimens, however, show this darker coloration. Similar color and size-variations exist in five specimens from British Honduras and three from the Caribbean lowlands of Guatemala. All these birds in group two would be called *sumichrasti* Ridgway. Large series from tropical Tamaulipas are intermediate and might be called either. Proceeding out to the tip of the Yucatan Peninsula, another good series shows no size difference but a minutely paler coloration on the average than typical *sumichrasti*. These birds are called *yucatanensis*, but they cannot be distinguished from the Tamaulipas intermediates by either color or size, nor can they be separated from the paler specimens of *sumichrasti*. Turning now to western Mexico, large series from Sinaloa to Oaxaca show another slightly paler bird (called *nelsoni*) but similar in size to *sumichrasti*. These birds also get darker and smaller as we proceed southward along the Pacific slope, so that Oaxaca specimens are practically indistinguishable from *yucatanensis*. I have seen no material from Chiapas, but the bird of the Pacific lowlands of Guatemala is dark and so small that it exactly resembles large series from farther south in Central America. One specimen from western Vera Cruz is intermediate between typical *sumichrasti* and Oaxaca specimens of *nelsoni*, and it follows that these are inseparable from series from Yucatan and tropical Tamaulipas.

It is obvious that no nomenclature can be devised to reconcile every one of the facts brought forward above. If the discussion has been followed on the map, however, it will be apparent that the darker specimens (as regards northern Central America) are restricted to the most humid areas, where the annual rainfall exceeds 100 inches. These birds are surrounded on three sides by paler birds in less humid and less heavily forested country, which northward pass to one extreme, *merrilli*, and northwestward to another, *nelsoni*. It follows, therefore, that the greater part of Mexico is occupied by one form, for which the earliest name is unfortunately *yucatanensis* Nelson. A well-marked, large and pale extreme, *merrilli*, is found in southern Texas and northeastern Tamaulipas, and a less-marked paler race occurs in Sinaloa, Jalisco, and Colima. The suppression of the latter race would certainly not do violence to any obvious facts. The so-called dark race, *sumichrasti*, has, however, no claims to existence whatever, as the alleged darkness affects only 40 per cent of the large series available. The variation in forty specimens taken within a few miles of each other in Alta Vera Paz includes most of the color characters claimed for the majority of the races of this bird.

Nyctidromus albicollis intercedens, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to typical *Nyctidromus albicollis* (Gmelin) of the Guianas, northern Brazil and eastern Venezuela, but underparts averaging paler and much larger, the wing of males averaging about 156 mm. as against 148 mm.; similar also to *N. albicollis yucatanensis* of northern Guatemala and most of Mexico, but averaging darker (the majority of the specimens as dark as the dark extreme of *yucatanensis*) and much smaller, the wing of the latter averaging 170 mm. or even more.

TYPE.—No. 136,601, Mus. Comp. Zoöl.; ♂ ad.; Tela, Honduras; March 4, 1928; J. L. Peters.

SPECIMENS EXAMINED

N. albicollis intercedens.—Guatemala (Pacific lowlands): Hacienda California, 3 ♂, 1 juv.; Finca El Espino, 2 ♂; Finca El Cipres, 1 ♀. Several hundred specimens from every other part of Central America, the Canal Zone, and the Pearl Islands. The relatively few specimens examined from western Colombia, western Ecuador, and northwestern Peru probably belong here.

N. albicollis albicollis.—Eight specimens from northeast Venezuela, Surinam, and Trinidad.

Several people have known for some time that Central American parauques were not typical *albicollis*, but the description of this form has awaited a study of the Mexican forms, now made necessary in determining the material from Guatemala in the Dwight Collection. Todd, in particular, has an interesting paragraph in his 'Birds of Santa Marta,' page 219. I can see no valid subspecific character in the amount of black streaking on the pileum in the gray phase, but the underparts, particularly the belly, undoubtedly average paler and less rufescent in the Central American bird. The average size difference is much more readily apparent.

Even if the conclusions given above are accepted, the situation is far from satisfactory, and there are large areas from which I have seen no material. What is apparent is that, starting with a small, dark bird in the Guianas, we have a steady increase in size as we go northward. I do not know where in South America to draw the line between *albicollis* and *intercedens*, just as we are unable at present to fix the boundaries between *albicollis* and the very distinct *derbyanus*. In Guatemala, however, there is a sharp break in size, and Mexican birds are obviously as large again as are Central American birds compared with those from Guiana. Finally, we pass with relative rapidity to the pale giant, *merrilli*, in southern Texas. Disposing of the two sharply contrasted extremes, we find variously intermediate birds occupying an enormous geographic area, and the problem of the systematist is to decide how many intermediate races he will "carve out," and on what basis he will draw the lines between them. It seems to me in this case that two intermediate races are ample: both have average characters of color and size, and both occupy relatively extensive areas.

Returning for a moment to my previous discussion of the Mexican races, we get, I think, further indorsement for suppressing some of them at least, after having considered the variations of the species over the rest of its range. It will be apparent that their claims to recognition are second rate, compared with those of the five races already admitted as distinct. They do not differ from each other as markedly in both color and size, as do the races of major value. As a matter of fact, Mexico does not happen to be alone in possessing a difficult assemblage of minor variations. Thus, birds from the more humid sections of eastern Honduras are minutely darker than birds from the drier parts of western Costa Rica, and specimens from the rain-forests of Panama (both east and west) are similarly darker than birds on the drier Pearl Islands. The same contrast occurs between humid western Colombia and arid western Ecuador, and on the basis of size these last might be referred to either race. When these minor differences in Mexico were named, it merely happened that their describers had available as much material from Mexico as from the rest of the range of the species.

This disposition of the case will not seem satisfactory to the student who is engaged in an intensive study of some local area, and consesequently more interested in the minor differences he observes in his particular region. But I submit that the fact of real biological interest in a systematic study of the parauque is the definite proof which now exists that there is an exact correlation between the intensity of its coloration and the amount of rainfall in its habitat, and that it increases markedly in size as it approaches the temperate zone of both hemispheres. Once this is determined, it is obviously a mere matter of form how many of these progressively local variations are given a subspecific name. The systematist has already given his possible contribution to biology.

Caprimulgus ridgwayi minor, new subspecies

Subspecific Characters.—Not certainly separable in color from the only known male of *ridgwayi* from Sinaloa in The American Museum of Natural History, but very radically smaller; wing, 148 instead of 161; tail, 93 instead of 115; exposed culmen, 11.5 versus 15.5.

Type.—No. 58,537, Dwight Collection; ♂ ad.; Progreso, Guatemala; September 20, 1924; A. W. Anthony.

There is little to add by way of comment. The small size and the notable range extension make a formal description thoroughly justifiable. The type of *ridgwayi*, a female, came from Guerrero. The unique female type of *goldmani* Nelson came from Sinaloa near Mazatlan and is at most a race of *ridgwayi*, though the supposed male *ridgwayi* from Sinaloa may really be *goldmani*, with which unfortunately it has not been compared. In the M.C.Z., there is a female in the rufous phase from Patzcuaro, Michoacan.

Agyrtria candida pacifica, new subspecies

Subspecific Characters.—Similar to typical *Agyrtria candida* of the Caribbean slope of Central America but larger; bill heavier and stouter, averaging 0.5 mm. wider at base; sides and flanks averaging more extensively green.

Type.—No. 61,339; Dwight Collection; ♂ ad.; Finca Carolina, near Tumbador (Pacific Slope), Guatemala; October 24, 1925; A. W. Anthony.

Specimens Examined

Agyrtria c. candida.—Over 50 specimens from the entire range.

Agyrtria c. pacifica.—Finca Carolina, 11♂, 3 ♀, 1 ?

The white-bellied emerald has hitherto been unknown from the Pacific slope of Central America north of Costa Rica, and this colony in western Guatemala, in the small section where there is heavy rainforest, is an interesting discovery. The bill is the most obvious character in uninjured specimens. I append below some comparative measurements of the wings of males.

A. c. candida	49–52.5
A. c. pacifica	50–56

Hylocharis leucotis borealis, new subspecies

Subspecific Characters.—Similar to typical *Hylocharis leucotis* (Vieillot) of Vera Cruz, Mexico, but larger, the underparts much more extensively white, with less greenish, grayish or bronzy edgings and tips to the feathers in both sexes.

TYPE.—No. 224,208, Mus. Comp. Zoöl.; ♂ ad.; Pinos Altos, Chihuahua; July 2, 1888; M. Abbott Frazar.

SPECIMENS EXAMINED

Hylocharis leucotis borealis.—Chihuahua, 16 ♂ ad., 10 ♀ imm., 9 ♀; Sonora, 2 ♂, 2 ♀. Arizona birds, not seen in the present connection, belong here also. A series of 5 ♂, 2 ♂ from Tamaulipas (Galindo and Realito) are intermediate, but a trifle nearer *borealis.*

Hylocharis l. leucotis.—San Luis Potosi, 1 ♂; Mexico, 2 ♂, 1 ♀; Jalisco, 4 ♂; Guerrero, 1 ♂, 1 ♀; Vera Cruz, 1 ♂, 1 ♀; Guatemala, a series of 34 ♂, 19 ♀ from fourteen localities in the Pacific and Central highlands. Birds from the more southern parts of the Pacific highlands show a slight approach to *pygmæa.*

With the large series now available from southern Mexico and Guatemala, it is at once apparent that northern birds are quite different. In the whiter underparts they suggest *pygmæa* Simon and Hellmayr, but the latter has the green of the throat much restricted, the outer tail-feathers of adult males broadly tipped with brownish gray, and is a smaller bird even than *leucotis.* It is a third well-characterized form. The *Trochilus leucotis* of Vieillot was erroneously ascribed to Brazil. I designate Orizaba, Vera Cruz, Mexico, as the type-locality.

MEASUREMENTS OF ADULT MALES

	Wing	Culmen
borealis	56–59 (57)	17–19 (18)
leucotis	53–56 (54.5)	15–16.5 (16)
pygmæa	52–54 (53)	14–15 (14.5)

Piculus rubiginosus maximus, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Piculus rubiginosus yucatanensis* (Cabot) of Yucatan but much larger; upperparts greener and less golden; underparts much greener, the chest almost without or entirely devoid of the golden brown wash, so characteristic of *yucatanensis.*

TYPE.—No. 63,736, Dwight Collection; ♂ ad.; Chanquejelve (5000 ft.) Huehuetenango, Guatemala; January 24, 1927; A. W. Anthony.

RANGE.—Eastern and central portions of the Pacific highlands of Guatemala, from 5000–6500 ft. Perhaps also in adjacent portions of Chiapas and the highlands of Salvador.

Piculus rubiginosus differens, new subspecies

SUBSPECIFIC CHARACTERS.—Intermediate in color between *Piculus rubiginosus yucatanensis* and *maximus,* nearest the former above, nearer the latter on the chest; size as in *yucatanensis;* differing from both in the finer mottling or streaking of chin and throat.

TYPE.—No. 61,383, Dwight Collection; ♂ ad.; Finca Carolina, ten miles south of Tumbador, District of San Marcos, alt. 3000 ft., on the Pacific slope of Guatemala; October 29, 1925; A. W. Anthony.

RANGE.—Pacific slope of Guatemala below 3500 ft. Perhaps also in adjacent portions of Chiapas and Salvador.

SPECIMENS EXAMINED

Piculus rubig. yucatanensis.—Vera Cruz, 2 ♂, 1 ♀; Tehuantepec, 1 ♂; Yucatan, 3 ♂, 1 ♀ (including type); British Honduras, 2 ♂, 1 ♀; Guatemala, series of 23 from five localities in the Caribbean rainforest of Alta Vera Paz (alt. 1200–3500 ft.).

Intermediates between *yucatanensis* and *maximus*.—A series of 10 from Finca Primavera, 30 miles southwest of Coban in Baja Vera Paz (alt. 3500 ft.).

Piculus rubig maximus.—Guatemala: Chanquejelve, 1 ♂, 1 ♀; Chichicastenango, 2 ♂; Panajachel, 1 ♂, 3 ♀; San Lucas, 3 ♂, 1 ♀.

Piculus rubig. differens.—Guatemala, Pacific slope: Finca Carolina, 2 ♂, 4 ♀; Finca El Cipres, 3 ♂, 2 ♀; Pantaleon, 1 ♂; San Felipe, 2 ♂.

MEASUREMENTS OF WING

	Males	Females
yucatanensis	116–126	116–123
maximus	127–134	126–129
differens	121–129	116–126

The large series of this green woodpecker collected by Anthony almost doubles the number of specimens in the country from northern Central America and brings out definite geographic variation in Guatemala, a highly diversified region. The large, green highland form is very distinct and needs no further characterization. The Pacific slope form is less marked but is not geographically intermediate. The intermediates from Baja Vera Paz listed above are an interesting lot. In size they are much nearer *maximus*, but the majority have more or less orange-brown on the chest like *yucatanensis*. It is highly probable that increased material will result in the description of two more forms in the area formerly assigned to *yucatanensis*. The three specimens from the Yucatan Peninsula differ from all others in being whiter, less bright yellow on the abdomen, belly and under tail-coverts. Three specimens from British Honduras are also distinctly greener on the chest than birds from adjacent areas. It is possible, therefore, that in time *yucatanensis* will be restricted to the Yucatan Peninsula, and its name will finally become appropriate.

In Costa Rica and western Panama we have a distinct form, *uropygialis* (Cabanis), which is strictly subtropical. I have never seen specimens from either Salvador or Honduras, but thirteen specimens from various parts of Nicaragua are, as might be expected, intermediate between *yucatanensis* and *uropygialis*. Curiously enough, however, individuals nearer *yucatanensis* occur near the Costa Rican boundary, and certain specimens from the northern highlands are distinctly nearer *uropygialis*. This erratic type of variation also occurs in Guatemala, and is perhaps correlated with the tendency in all races of this woodpecker to produce more highly colored individuals. Thus, females sometimes are red in areas normally red only in males, the red in males is occasionally abnormally developed, and one specimen is before me in which the feathers of the back are tipped with red.

AMERICAN MUSEUM NOVITATES

Number 380 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Oct. 21, 1929

59.82 (87)

DESCRIPTIONS OF NEW BIRDS FROM MT. DUIDA, VENEZUELA

BY FRANK M. CHAPMAN

For the past twenty years or more it has been the aim of the American Museum to explore the mountain mass near the headwaters of the Orinoco, known as Mt. Duida. In the fall of 1912, Mr. Leo E. Miller was given this commission. He reached the vicinity of the mountains on the Rio Cunucunuma when the illness of his associate compelled him to abandon the undertaking.

Nearly sixteen years passed before circumstances favored our making a further attempt on Duida. Then, thanks to the financial support of Mr. Sidney F. Tyler, Jr., of Philadelphia, a well-equipped expedition left New York on July 21, 1928, bound for the upper Orinoco by way of the Amazon and Rio Negro. It was under the leadership of Mr. G. H. H. Tate of the museum staff, who was accompanied by Mr. Tyler as historian and photographer, Mr. Charles B. Hitchcock as topographer and geologist, and Mr. Raymond S. Deck as ornithologist. At Manaos the expedition was joined by the museum's Ecuadorean collectors, Alphonse and Ramon Olalla, together with their four assistants. Esmeralda, the base of operations on the upper Orinoco, was reached October 1, 1928 and the expedition embarked from this place on the return journey on March 14, 1929.

During the intervening four months and a half a trail was made up the Duida escarpment, which was found to be the southeast face of a basin-tableland, some 250 square miles in area, having an elevation of from 4200 feet at its bottom to 7800 feet on the bordering peaks. The slopes of the mountain, except on vertical cliffs, and almost the entire tableland were found to be so densely forested that it was possible to collect only after trails had been cut. About forty miles of such trails were made, permitting the formation of a collection of 6748 birds, which it is believed fairly represents the bird-life of the region between Esmeralda and Mt. Duida, the neighboring slopes, and the tableland of the mountain. Large collections were also made of [illegible]als and plants, and data were secured with which to make an adequate topographical map of a hitherto unknown area. In short, the expedition achieved all its objectives.

In describing[1] the new birds secured by the Lee Garnett Day expedition to Mt. Roraima in 1927, I said that a detailed report on the collection made by this expedition was withheld in the hope that the work then in progress on Mt. Duida might throw some light on the problems presented by the study of our Roraiman material. It is too early to say to what extent this hope has been fulfilled but it can be said in advance of a final report, that the avifauna of the upper life-zone on Mt. Duida is almost purely Roraiman. Species after species, heretofore known only from Mt. Roraima, were found on Duida and even the races of variable species, which we have believed to be restricted to Roraima, appear unchanged on Duida. This close faunal affinity indicates either that in the approximately 375 miles by which these two mountains are separated there are areas of sufficient elevation virtually to connect the ranges of their distinctive life, or that such connection has existed at no very remote period.

The greater number of the birds herein described are representative species or races of Roraiman birds, but several are so distinct that their recent ancestry is not evident. There are also a number of exceptionally interesting zonal forms apparently derived from ancestors still existing at the base of the mountain; notable among these are the representatives of *Glaucidium brasilianum*, *Otus choliba*, *Taraba major*, and *Emberizoides herbicola*. The collection from the Tropical Zone at the base of Duida has not as yet been studied, but I have described from it several forms which seem obviously new.

In the belief that no other designation would be as appropriate or convey as much information, I have not hesitated to use the name "*duidæ*" for most of the birds from Mt. Duida's upper life-zone.

These descriptions are published in advance of a paper planned to treat of the affinities and geographical origin of the distinctive birds of both Roraima and Duida, as an announcement of the major ornithological results of the Tyler Duida Expedition, to avoid the necessity for the inclusion in the final report of the descriptive matter, measurements, etc., incident to the naming of new birds, and to supply these birds with titles under which their status may subsequently be discussed.

I am indebted to the authorities of the Carnegie Museum, Museum of Comparative Zoölogy, and Field Museum for the loan of specimens which have been of invaluable assistance in the preparation of this paper.

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[1] 1929, Amer Mus. Novitates, No. 341, Feb.

Crypturornis casiquiare, new species

SPECIFIC CHARACTERS.—A member of the *Crypturornis variegatus–C. strigulosus* group with a gray breast, no rufous below, a chestnut crown, and barred back.

TYPE.—No. 245,912, Amer. Mus. Nat. Hist.; ♀ ad.; ovaries enlarged; right bank of Rio Casiquiare at its junction with the Rio Guainia, Venezuela; May 7, 1929; Olalla Bros.

DESCRIPTION OF TYPE.—Crown, sides of head and nape chestnut, the black bases of the feathers more or less exposed on the crown; hind-neck hair-brown with a drab tinge passing into the broad, black and ochraceous bars which extend from the fore-back to upper tail-coverts and tail; wings fuscous; inner coverts and tertials barred like the back; throat snowy white, changing quickly into the light neutral gray of the front and sides of the neck and sides of the breast; the center of the breast narrowly white broadening posteriorly into the white abdomen; flanks barred with cream and black; lower tail-coverts ochraceous-buff with some basal, black markings; tibiæ grayish; feet brownish black; maxilla blackish; mandible yellowish horn black-tipped. 2 ♀: wing, 135–140; tarsus, 46; culmen, 25 mm.

SPECIMENS EXAMINED

Crypturornis casiquiare.—VENEZUELA: Junction Casiquiare and Guainia, 2 ♀.

Crypturornis strigulosus.—BRAZIL: Santarem, 1.

Crypturornis variegatus.—BRITISH GUIANA, 5 ♂, 4 ♀. VENEZUELA: Foot Mt. Duida, 12 ♂, 3 ♀. Eastern ECUADOR, 2 ♂. Eastern COLOMBIA, 1 ♂. Eastern PERU, 4 ♂, 8 ♀.

From our single unsexed specimen of *strigulosus* (wing, 158 mm.), *casiquiare* differs chiefly in its smaller size, barred mantle as well as rump, and pure gray breast and sides. It is not probable that the male of the bird here described differs materially from the female.

Odontophorus guianensis medius, new subspecies

SUBSPECIFIC CHARACTERS.—Prevailing color of the underparts bright ochraceous-tawny as in *Odontophorus guianensis guianensis* (Gmelin); prevailing color of the sides of the head and throat gray as in *Odontophorus guianensis buckleyi* Chubb. More richly colored below than *marmoratus*, the cheeks gray rather than ochraceous-tawny, the throat gray, nearly uniform, instead of barred or spotted with white.

TYPE.—No. 245,913, Amer. Mus. Nat. Hist.; ♂ ad.; Caño Seco, Mt. Duida, Venezuela, 2250 ft.; Dec. 26, 1928; Olalla Bros.

SPECIMENS EXAMINED

Odontophorus guianensis medius.—VENEZUELA: Esmeralda, 1 ♀; Ft. Duida, 725 ft., 1 ♀; Caño Seco, 2250 ft., 3 ♂, 1 ♀; Aguita, 3250 ft., 1 ♀, 1 ♂ pull. (Jan. 7, 1929); right bank Casiquiare, at junction with Rio Guainia, 2 ♂, 1 ♀.

Odontophorus guianensis guianensis.—BRITISH GUIANA: Potaro Landing, 2 ♂, 1 ♀; Kamakusa, 1 ♂, 1 ♀. BRAZIL: Santarem, 1.

Odontophorus guianensis marmoratus.—VENEZUELA: Sta. Elena, head of Maracaibo,[1] 1 ♂. COLOMBIA: El Tamber, Santander,[1] 1 ♂, 1 ♀; Palmar, Boyaca,[1]

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[1] Coll. Carnegie Mus.

1 ♀; Puerto Valdivia, Antioquia, 2 ♂; Murindo, Antioquia,[1] 1 ♀; Sautata, Rio Atrato,[1] 1 ♂. PANAMA: Cana,[2] 1 ♂, 3 ♀; Cituro, 1 ♂, 1 ♀; Boca de Cupe, 2 ♂; El Real,[2] 1 ♂; Tacarcuna, 2 ♂, 2 ♀; Tapalisa, 2 ♂, 1 ♀; Canal Zone, near Panama,[2] 2 ♂; near Lion Hill, 1 ♂, 1 ?; Line P. R. R.,[2] 1 ♂.

Odontophorus guianensis buckleyi.—COLOMBIA: Buena Vista, 1 ♂; La Morelia, 1 ♂. ECUADOR: Rio Suno, 4 ♂, 3 ♀; below San José, 2 ♀. PERU: Puerto Indiana, mouth of the Napo, 1 ♂, 1 ♀. BRAZIL: Tonantins, left bank of the Solimões,[1] 2 ♂, 1 ♀.

Odontophorus guianensis pachyrhynchus.—PERU: Chanchamayo,[3] 1 ♀.

In order to determine the status of the form here described I have examined all the specimens of the group in the American Museum and I am indebted to the Carnegie Museum, the Museum of Comparative Zoölogy, and Field Museum for the loan of others. While this material is not sufficient to permit of a thorough review of the races of *Odontophorus guianensis* it does warrant the presentation of some provisional conclusions.

This species varies so greatly both in color and pattern that local series are required to distinguish racial from individual variation. For example: four males and five females of *O. g. buckleyi* from the Rio Suno, eastern Ecuador, in the general tone of the underparts, vary from gray to Dresden brown, the latter prevailing; while the range in pattern below is from nearly uniform Dresden brown to that color strongly barred with black and ochraceous-buff.

Eight males and four females from eastern Panama show nearly as wide variation in pattern but less in color, the prevailing color being richer than in *buckleyi,* nearer antique brown. The color and pattern of the throat and color of the sides of the head, which furnish the principal diagnostic markings, are also subject to much variation. The need of series, then, in determining the races of this species is obvious.

Heretofore,[4] when dealing with this group, I have had but one specimen from the "Bogotá" region. It does not agree with two specimens from western Colombia (Puerto Valdivia), and while the latter are more nearly like Gould's description of *marmoratus,* they were taken so far from the Bogotá region that I was uncertain whether they or my single specimen from Buena Vista, east of Bogotá, represented true *marmoratus.* Thanks to Mr. Todd, I am now in possession of three specimens from the eastern Andes (Palmar, Boyaca, and El Tamber, Santander) which agree with Gould's description in having the "ear-coverts reddish chestnut" and I think that they may safely be considered topotypical of his *marmoratus*. These specimens are much alike in color and markings but if, as seems probable, the species is as variable in the region whence they came as our series shows it to be in other parts of its range, they represent only one phase of the color and markings of topotypical *marmoratus*. Nevertheless, even with this restriction, they lead to conclusions quite at variance with those now current. They show that the Buena Vista bird, provisionally referred to *marmoratus*, is not that race. They show also, in my opinion, that the bird of the Canal Zone, for which I have proposed the name *Odontophorus guianensis panamensis*, is not separable from *marmoratus*. All three east Andean birds have the white chin and white-marked throat heretofore supposed to be characteristic of Panama birds, and in other respects they can be matched by my four adults from the Canal Zone. One of the two Santander specimens is, indeed, practically a duplicate of the type of *panamensis*.

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[1] Coll. Carnegie Museum.
[2] Coll. Mus. Comp. Zoöl.
[3] Coll. Field Mus
[4] 1915, Bull. Amer. Mus. Nat. Hist., XXXIV, p. 363; 1917, XXXVI, p. 200.

If east Andean and Canal Zone specimens are alike, we should expect to find that birds from the intervening area are also referable to *marmoratus*. This quail is a bird of the humid Tropical Zone, where, as an inhabitant of primeval forest, its habitat does not differ greatly in character with locality, and doubtless for this reason its races usually range over extensive territories.

Unfortunately, as I have said, my topotypical series is too small to show the wide range of individual variation exhibited by this species. I turn, therefore, to the evidence presented by other specimens. For example, a male from Santa Elena, near the head of the Gulf of Maracaibo, Venezuela (Carnegie Mus. No. 90727), has the underparts heavily and evenly barred, there is a tint of rufous on the chin, the throat is more gray than white, the gray mantle is broadly barred with black. Seen alone, both its markings and locality would indicate its racial difference from *marmoratus*, but it is almost exactly duplicated by a female from Murindo, Antioquia, western Colombia (Carnegie Mus. No. 64364). When we also discover that a male from Sautata, Rio Atrato, western Colombia (Carnegie Mus. No. 63929) agrees with the Santander specimens and is thus typical of *marmoratus*, we must conclude that only one race occupies the region from the Maracaibo basin to western Colombia.

There remain the birds from eastern Panama. Mr. Griscom has described his specimens from Cana as *Odontophorus guianensis chapmani;* but while he mentions the intermediate characters of a specimen from El Real, he refers it to "*panamensis*." But Cana and El Real are both in the Tropical Zone and separated by only twenty-five miles. It is difficult to believe that specimens of this species from these two localities would be separable. Indeed, with four of Mr. Griscom's Cana specimens and his El Real specimen, together with eleven additional specimens from eastern Panama before me, I can distinguish only one race. The question is, what are the affinities of these birds? Mr. Griscom's reference of specimens from El Real, Mt. Sapo, and Jesusito to "*panamensis*" indicates their close resemblance to the Canal Zone bird, and turning in the other direction, I can match numbers of specimens from eastern Panama in the series from western Colombia. I do not find among these eastern Panama specimens any as light-colored as the three topotypes of *marmoratus* and this fact prevents me from reaching a wholly satisfactory conclusion concerning their relationships. I have no doubt, however, that they represent but one form, and if this form is separable from *marmoratus* it presumably divides the range of this race, for certainly my small series of birds from the East Andes and Canal Zone is not separable. For the present, therefore, I should recognize only *marmoratus*, accord it a range from Maracaibo to the Canal Zone and synonymize with it *panamensis* Chapman[1] and *chapmani* Griscom.[2] I have not seen the type and only recorded specimen of *polionotus* Osgood and Conover,[3] from the west side of Maracaibo, but the characters ascribed to it and the colored plate illustrating it in connection with the facts above stated suggest that, like the specimen from near the southern end of Maracaibo, it is also referable to *marmoratus*.

Turning now to the Buena Vista specimen, comparison of it with the three Carnegie Museum birds, which I consider topotypical of *marmoratus*, shows that it is obviously not that race. With this question settled, it seems clear, that together with a bird from La Morelia in southeastern Colombia, it is not separable from *O. g. buckleyi* of eastern Ecuador south to the Marañon, and eastward, possibly, to the upper Rio Negro. Thanks to Director S. C. Simms, I have received from the Field Museum a specimen from Chanchamayo, eastern Peru, topotypically representing *pachyrhynchus* Tschudi. In this instance it requires only a single specimen to show that *buckleyi* Chubb is wholly distinct from the form of eastern Peru south of the Marañon. The eastern Ecuador form is the grayest of the known races. In its extreme development the chin and throat are uniform gray or brownish gray unmarked, but the chin, and sometimes the whole throat, is faintly barred but not as strongly marked as in *marmoratus*, and not one of my series of sixteen specimens approaches the single specimen of *pachyrhynchus* in its rich chestnut throat, chin and cheeks. The latter, indeed, differs from true *guianensis* only in its somewhat darker upperparts, especially darker crown, slightly paler lowerparts and redder throat. In the latter respect it resembles our Santarem specimen (Amer. Mus. No. 36492). The two birds are, indeed, enough alike to be referred to the same race, but beyond this statement I do not venture, except to add that should there prove to be a form from the southern side of the Amazon, referred by Hellmayr to true *guianensis*, *rufina* (Spix) might be the name for it. Measurements show that the male averages larger than the female but reveal no constant geographic variation in size, though the bill in *marmoratus* may be slightly smaller.

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[1] 1915, Bull Amer. Mus. Nat. Hist., XXXIV, p. 363.
[2] 1929, Bull. Mus Comp. Zool., LXIX, p. 153.
[3] The Auk, 1927, XLIV, p. 561.

Otus choliba duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Darker than any known member of either the *choliba* or *asio* group; the prevailing color of the upperparts black, with vermiculations and broken markings of shades of buff and ochraceous-buff; underparts heavily striped and closely barred with black, the basal half, more or less, of the feathers ochraceous-buff, giving a pronounced suffusion of this color.

TYPE.—No. 245,914, Amer. Mus. Nat. Hist., ♂ ad.; Mt. Duida, Venezuela, 5000 ft.; January 3, 1929; Olalla Bros.

SPECIMENS EXAMINED

Otus choliba duidæ.—VENEZUELA: Mt. Duida, 4700 ft., 2; 5000 ft., 2.

Otus choliba choliba.—ARGENTINA: Santiago del Estero, 1; Embarcacion, 1.

Otus choliba decussatus.—BRAZIL: Chapada, Matto Grosso, 4; Veruga, S. Bahia, 1; Boa Nova, Bahia, 1; Santa Rita, Bahia, 3; Bahia, 2; Floriano, Piauhy, 1; ?São Paulo, 1 (richly colored).

Otus choliba crucigerus.—PERU: Santa Ana, Urubamba, 2; Lagarto Alto, Ucayali, 1. ECUADOR: Curaray, 1. COLOMBIA: Villavicencio, 1; Anolaima, 4; Dabeiba, Antioquia, 1. VENEZUELA: Mérida region, 9; Esmeralda, Orinoco, 1; Ft. Duida, 725 ft., 1; Caicara, Orinoco, 1; Bolivar, Orinoco, 1. B. W. I.: Trinidad, 3.

This is, I believe the first zonal form of *Otus choliba* to be described as such, though it is not improbable that the large *ingens* Salvin, from Jima, Ecuador, may be a Temperate Zone representative of this species. We have two specimens of *crucigerus* from the region at the base of Duida, which show no approach to *duidæ*. Lacking topotypical specimens of *crucigerus* and also of *choliba*, I am unable to identify much of our material satisfactorily. Our four specimens of *duidæ* agree closely and, in the heavy black markings below, they are nearer to three birds from northern Argentina than to any others; but whether these Argentina birds are true *choliba*, I am unable to say. Three examples from Chapada, Matto Grosso, agree in color and size (♂: wing, 155–157; tail, 82–83 mm.) with the small, comparatively pale and lightly marked *decussatus*, of which we have an excellent topotypical series. A fourth Chapada specimen resembles the others in size but is in an extreme ochraceous-tawny phase of plumage. The rest of our South American specimens of this species I provisionally refer to *crucigerus*.

THE *Glaucidium brasilianum-nanum* GROUP

In determining the relationships of the form of *Glaucidium brasilianum* inhabiting the upper life-zone on Mt. Duida, I have of necessity examined our large series of this group and I present here some of the results of this study including the description of a very distinct form from the upper Amazon which, because of the wide variation prevailing amongs these owls, has heretofore been confused with true *brasilianum*.

Glaucidium brasilianum duidæ, new subspecies

SUBSPECIFIC CHARACTERS (brown phase).—Upperparts more richly colored than in the other races of this group, varying from Saccardo's umber (one specimen) to warm olive-brown (three specimens), nearly as dark as some specimens of *G. jardini;* all five specimens with as much black in the nuchal ring as *jardini;* back immaculate without even concealed markings; crown from bill to nape with fine white or ochraceous shaft-streaks; tail black with five white, incomplete bars, exclusive of rudimentary basal bar and tip; rictal bristles and ear-coverts largely black; Saccardo's umber markings of underparts of about the same shade as in the corresponding phase of *b. brasilianum*, but much more extensive, occupying a greater area than the white markings and almost meeting on the breast to enclose a white chest-spot. Five males: wing, 95–101; tail, 55–62 mm.

TYPE.—No. 245,915, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 4700 ft.; February 22, 1929; Olalla Bros.

RANGE.—Subtropical Zone, Mt. Duida, Venezuela.

In some respects this very distinct zonal race is between *brasilianum* and *jardini*, a fact which suggests that the latter may also be a zonal representative of *brasilianum*. The round spots on the crown which characterize *jardini* are not a constant marking, for we have specimens from Baeza, eastern Ecuador (1), and Mérida, Venezuela (3), in which the crown is more finely streaked than in the average specimen of *brasilianum*. I am not sure, indeed, that the Mérida bird is not separable.

It is interesting to observe that the zonal form of *brasilianum* in northern Argentina, *G. b. tucumanum* from Rosario de Lerma (4800 ft.), Salta, is also a deeply colored race, the upperparts being fuscous with barely a tint of brown. In our three specimens of this bird, however, there is almost no indication of black in the nuchal band and the crown-stripes are mere hair-lines. As in *duidæ*, the back in *tucumanum* is unmarked, but so great is the variation in this group it by no means follows that an immaculate back is a constant characteristic of either of these two races.

Glaucidium brasilianum ucayalæ, new subspecies

SUBSPECIFIC CHARACTERS (red phase, 11 specimens. No gray phase ?).—Upperparts bright argus brown, crown uniform with back, shaft-streaks barely evident or wholly absent; nuchal collar with more or less black; tail somewhat brighter than back, bars poorly developed or almost wanting; darker markings below of about the same color as the back, as heavily developed as in *G. b. duidæ*. 3 ♂: wing, 98–106, tail, 59–62. 5 ♀: wing, 99–106; tail, 58–65 mm.

(Brown phase, 2 specimens).—Less rufescent than red phase, Brussels brown rather than argus brown; shaft-stripes present as hair-lines; tail like back, the black bars faint but complete, markings below the same color as back, and of same extent as in red phase. Averaging slightly larger than *brasilianum*.

TYPE.—No. 237,712, Amer. Mus. Nat. Hist.; ♂ ad.; Sarayacu, Rio Ucayali, Peru; April 19, 1927; Olalla Bros.

RANGE.—Eastern base of eastern Andes from southeastern Colombia to Peru.

Glaucidium brasilianum is a bird of open, scattered growth rather than of heavy forests. We have a large series from the arid Tropical Zone in western Ecuador, but have yet to take a single specimen in eastern Ecuador. From the banks of the Marañon and Ucayali the Olallas have recently sent us a series of a strongly marked form which in its rich, saturated colors appears to express the influences of the humid region in which it lives. Here, also, obviously belongs a specimen from southeastern Colombia, the rich color of which has long excited my interest.

The range of this race is evidently bounded on the west by the extent of the humid Tropical Zone, for as soon as we reach the arid tropics at the Rio Chinchipe in the lower Marañon Valley, we find a bird I am unable to separate from true *brasilianum*. This race is apparently, therefore, segregated in western Ecuador and western Peru from the main area it occupies. In tracing its range southwest in western Peru I have encountered the question of its relationships to *Glaucidium nanum*. Hence, the following notes.

Compared with *Glaucidium b. brasilianum*, the characters of *Glaucidium nanum nanum* (King) and *G. n. vafrum* Wetmore, as shown by 20 specimens, are greater extent of the dark markings below (in this respect resembling *duidæ*), and heavy spotting on the sides of the breast (present in *jardini* but not (?) in *duidæ* and only rarely in *brasilianum*);

while in the brown, as well as rufous phase of plumage, the tail is barred with rufous instead of black barred with white.

While I fully agree with Dr. Wetmore that it is highly probable *brasilianum* and *nanum* will be found to intergrade, my material does not demonstrate this intergradation. East of the Andes I have no material south of northern Argentina, but on the Pacific Coast we have a female of *G. n. vafrum* from Moquegua, in southwestern Peru, which is wholly typical of this form, the black tail-bars being double the width of the rufous ones (wing, 107; tail, 76 mm.). Two males from Vitor, Province of Arequipa, about 85 miles northwest of Moquegua, are equally typical of true *brasilianum* (wing, 97.98; tail, 65,68 mm.), the rufous bars in the tail being wider than the black ones, and from this point *brasilianum* occurs northward at least to Ecuador. If between Moquegua and Vitor these forms intergrade, their fusion is doubtless accomplished by the hybridization of a mutant with the parent stock rather than by gradual mergence through climatic conditions.

SPECIMENS EXAMINED

Glaucidium brasilianum duidæ.—VENEZUELA: Mt. Duida, 3250 ft., 1 ♂; 4700 ft., 3 ♂; 5000 ft., 1 ♂.

Glaucidium brasilianum tucumanum.—ARGENTINA: Rosario de Lerma, 4800 ft., 3.

Glaucidium brasilianum brasilianum.—ARGENTINA: Santiago del Estero, 2 (brown), 2 (gray). BRAZIL: Matto Grosso, 4 (red), 5 (brown); Bahia, 4 (red), 2 (brown), 2 (gray); Maranhão, 3 (red), 1 (gray); Ceará, 1 (red). Western ECUADOR, 9 (red), 15 (brown), 5 (gray). PERU: Prov. Piura, 6 (red), 4 (brown), 1 (gray); Huancabamba, 2 (gray), 2 (brown); Rio Chinchipe, 2 (brown), 2 (gray); Poroto, La Libertad, 3 (red), 1 (gray); Pisco, 1 (red); Vitor, Arequipa, 2 (red); Ollantaytambo, Urubamba, 9700 ft., 1 (gray; typical).

Glaucidium brasilianum ucayalæ.—PERU: Santa Rosa, upper Ucayali, 1 (red); Sarayacu, Ucayali, 4 (red); Rio Seco, near Moyobamba, 1 (brown); Orosa, Marañon, 2 (red); Puerto Indiana, Marañon and Napo, 3 (red); Apiyacu, near Pebas, Marañon, 2 (red), 1 (brown). COLOMBIA: Florencia, 1 (red).

Glaucidium brasilianum phalænoides.—B. W. I.: Trinidad, 4 (red), 1 (brown), 3 (gray). VENEZUELA: Cristobal Colon, 1 (red), 1 (gray); Cumanaçoa, 2 (red); El Cuji, Lara, 2 (gray?); Ayacucho, Orinoco, 1 (brown).

Glaucidium brasilianum medianum.—COLOMBIA: Bonda, Sta. Marta, 2 (red), 3 (brown), 1 (gray); Barranquilla, 1 (gray).

Glaucidium nanum nanum.—CHILE: Tierra del Fuego, 1 (gray); Punta Arenas, 2 (gray); Angol, 2 int. (gray); Temuco, 4 int. (red).

Glaucidium nanum vafrum.—CHILE: Santiago region, 5 (brown), 4 (gray); Rio Blanco, 1 (gray); Tofo, 1 (gray). PERU: Moquegua, 1 (brown).

Touit purpurata viridiceps, new subspecies

SUBSPECIFIC CHARACTERS.—Resembling *Touit purpurata purpurata* (Gmelin) of Cayenne but entire crown, nape and sides of the head green, like the back; yellow of the sides slightly deeper; size, including bill, somewhat larger. 5 ♂: wing, 118–126; tail, 48–53; culmen, 18–20 mm.

TYPE.—No. 245,916, Amer. Mus. Nat. Hist.; ♂ ad.; Savanna Grande, 330 ft., southeastern base of Mt. Duida, Venezuela; February 4, 1929; Olalla Bros.

SPECIMENS EXAMINED

Touit purpurata viridiceps.—VENEZUELA: southeastern base of Mt. Duida, 330–725 ft., 5 ♂.

Touit purpurata purpurata.—FRENCH GUIANA: Mana River, 1 ♀. BRITISH GUIANA: Merumé Mts., 1 ♂ (new subsp. ?). No locality, Maximilian Coll., 1 ♂.

This form differs so greatly from true *purpurata* that I should be inclined to accord it specific rank were it not for the characters presented by a male from the Merumé Mts. in British Guiana. In this bird the forehead and nape are green, leaving only the center of the crown brown, of the same color as in the crown of *purpurata*. It is, therefore, fairly intermediate between the Cayenne and Duida forms but, if its characters are constant, it differs sufficiently from both to stand as a third race. However this may be, it certainly indicates the intergradation of the brown with the green-headed form.

DUIDIA, new genus

GENERIC CHARACTERS.—A member of the subfamily Micropodinæ, the outer toe with three phalanges, but tarsus nearly bare, and hind toe, as in other American members of this subfamily, more directly apposed to front toes than in the European genera of Micropodinæ; bill broader than long; tail but slightly forked, the rectrices broad and obtusely pointed; wing about two and a half times the length of tail.

TYPE.—*Duidia tatei*, new species.

Duidia tatei, new species

SPECIFIC CHARACTERS.—Not closely resembling any described species, general plumage shining bluish black, the throat, a ventral patch, and the tips of the rectrices white.

TYPE.—No. 245,939, Amer. Mus. Nat. Hist.; ♂ ad.; High Point Camp, Mt. Duida, Venezuela, 7100 ft.; January 12, 1929; G. H. H. Tate.

DESCRIPTION OF TYPE.—General color, including wings and tail, upper and lower wing- and tail-coverts, shining blue-black; throat, upper breast, abdominal patch, and a thin, broken, partly concealed line connecting them, white; ends of central rectrices grading from black into grayish white tips about 6 mm. wide, the three outer pairs of rectrices terminally margined with white decreasing in amount from within outward, two inner tertials in each wing narrowly tipped with white; feathers at the bend of the wing narrowly tipped with white. Anteorbital region grayish; auriculars brownish; feet brownish; bill black. Length (skin), 127; wing, 112; tail, to end of longest feather, 44, to end of shortest, 35.5; tarsus, 8; exposed culmen, 5; width of maxilla at nostril, 6 mm.

Our single specimen of this interesting new bird was shot by Mr. Tate on the summit of Mt. Duida and it is therefore particularly fitting that it should be named in his honor and in recognition of his labors as the leader of the Tyler Duida Expedition.

In its white throat, central white line below, and white-tipped inner wing-feathers the markings of this species suggest those of *Aëronautes melanoleucus;* the shape of the tail is also as in that species. The single feather on each tarsus may be the remains of a more feathered condition, but no other trace of feathers is now evident.

In the dried skin I find that the hind toe in all the American Micropodinæ tends to assume a position facing the front toes, much as in the Chæturinæ; whereas in skins of the Old World Micropodinæ the hind toe is inclined to range itself, if not with the front toes, certainly not apposed to them.

The fact that this is the second new genus of swifts to be described from Venezuela within the past two years indicates our comparative ignorance of those American tropical birds whose haunts are largely restricted to the upper air.

Doryfera johannæ dissita, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Doryfera johannæ johannæ* (Bourcier) of eastern Colombia to northeastern Peru, but smaller with a shorter bill; forehead in the male averaging bluer, less purple; underparts in the female darker and less washed with green; rump and upper tail-coverts in both sexes with less bluish gray.

TYPE.—No. 245,917, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 4700 ft.; January 16, 1929; Olalla Bros.

SPECIMENS EXAMINED

Doryfera johannæ dissita.—VENEZUELA: Mt. Duida, foot of Duida, 750 ft., 1 ♂; 2000 ft., 1 ♀; 2250 ft., 1 ♀; 3250 ft., 1 ♀; 4200 ft., 1 ♂; 4700 ft., 3 ♂, 3 ♀; 5000 ft., 1 ♂, 1 ♀; Mt. Roraima, 4200 ft., 1 ♀.

Doryfera johannæ johannæ.—ECUADOR: below San José de Sumaco, 6 ♂, 6 ♀. COLOMBIA: Bogotá, 3 ♂, 3 ♀; "New Grenada," 1 ♂ ("type").

MEASUREMENTS OF MALES

	No.	Wing	Tail	Culmen
D. j. dissita, 4200–5000 ft., Mt. Duida	4	53–55	27–29	24–27 mm.
D. j. johannæ, below San José de Sumaco	5	57–58	29–31	30–32.5

Doryfera johannæ is known chiefly from the Subtropical Zone. Stolzmann[1] states that at Huambo, Peru, he did not find it below 3700 feet; most Ecuadorean and Colombian records are from the Andes, while in Guiana it is known only from Mt. Roraima and the Merumé Mts. In Ecuador, however, we have ten specimens from below San José de Sumaco, which, judging by other birds found there, is in the Tropical Zone; and on Mt. Duida a single specimen was taken at the foot of the mountain and two at from 2000 to 2250 feet and hence in the Tropical Zone. While there are no records for this species from between Duida and the Andes, a distance of about 1000 miles, it may possibly occur there.

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[1] Orn. Pérou, I, p. 286.

Campylopterus duidæ, new species

SPECIFIC CHARACTERS.—Most nearly related to *Campylopterus rufus* Lesson of the highlands of Guatemala and *C. hyperythrus* Cabanis of Mt. Roraima, but underparts drab, the tail basally bronze.

TYPE.—No. 245,919, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 5000 ft.; January 7, 1929; Olalla Bros.

DESCRIPTION OF MALE.—Upperparts shining green with bronze reflections increasing in strength posteriorly, the upper tail-coverts being greenish bronze; four central rectrices bronze; outer three pairs apically deep ochraceous-buff, dull bronze at the base, this color occupying nearly half the outer pair, slightly more on the succeeding pair and about three-fourths of the third pair; wing-quills and their greater coverts purplish black; lesser coverts bronzy green; bend of the wing and axillars ochraceous-tawny; lower wing-coverts shining green more or less tipped with tawny; a small whitish postocular spot; lores more or less heavily suffused with ochraceous-tawny; prevailing color of the underparts drab tinted with ochraceous-tawny most strongly on the sides and flanks; lower tail-coverts pale ochraceous-buff; feet brownish black; bill black; the mandible usually paler basally. 5 ♂: wing, 66–69; tail, 46–48; culmen, 25–28 mm.

DESCRIPTION OF FEMALE.—The female resembles the male in color but the shafts of the outer primaries are not enlarged and curved. Five females: wing, 64–65; tail, 44–45; culmen, 26–29 mm.

SPECIMENS EXAMINED

Campylopterus duidæ.—VENEZUELA: Mt. Duida, 2250 ft., 1; 3250 ft., 1; 4700 ft., 3; 5000 ft., 6; 6200 ft., 2; 6700 ft., 3.

Campylopterus rufus.—GUATEMALA, 2.

Campylopterus hyperythrus.—VENEZUELA: Mt. Roraima, 6

Apparently a representative of the Roraiman species *C. hyperythrus* but in its marked tail it more nearly resembles the Guatemalan *C. rufus.*

Saucerottea cupreicauda duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Resembling *Saucerottea viridigaster viridigaster* (Bourcier and Mulsant) of the Bogotá region in having the rectrices essentially uniform, but rich bronze (like central rectrices of true *cupreicauda*) instead of dark livid purple or napthalene violet; the lower back, rump and upper tail-coverts golden bronze, green below extending farther back on the abdominal region, lower tail-coverts ochraceous-tawny only slightly paler than in true *cupreicauda*. Resembling *Saucerottea cupreicauda cupreicauda* (Salvin and Godman) of Mt. Roraima, but general coloration less golden green, tail in fresh plumaged adults, nearly uniform in color; in postjuvenal plumage all but the central rectrices narrowly tipped with tawny.

TYPE.—No. 245,940, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 4700 ft.; December 21, 1928; Olalla Bros.

SPECIMENS EXAMINED

Saucerottea cupreicauda duidæ.—VENEZUELA: Mt. Duida, 4200 ft., 2 ♀; 4700 ft., 3 ♂, 4 ♀; 5200 ft., 1 ♂, 1 ♀.

Saucerottea cupreicauda cupreicauda.—VENEZUELA: Mt. Roraima, 3500 ft., 1 ♂; 4200 ft., 4 ♂, 4 ♀; 6000 ft., 1 ♀.

Saucerottea viridigaster viridigaster.—COLOMBIA: "Bogotá." 4, including melanistic type of *incultus* Elliot; Quetame, 2 ♂, 2 ♀; Buena Vista, 3 ♂, 1 ♀; Villavicencio, 1 ♀. (Our specimens with exact locality are all from the eastern slope of the East Andes, while Fusugasugá, the type-locality of *viridigaster*, is on the western slope of this range. *Saucerottea v. melanura* Simon from the Bogotá region is probably based on individual variation, just as *incultus* Elliot is based on melanism. *S. v. iodura* Reichenbach, from the Mérida region, I have not seen.)

This is an intermediate between the Andean and Roraiman races, resembling the former in pattern but nearer the latter in color. In the adult of true *cupreicauda* the four central tail-feathers are bronze, sometimes tinged with purple apically, the lateral feathers are hazel or cinnamon-rufous with a purplish bronze tip increasing in extent from without inwardly. In adult *duidæ* all the rectrices are bronze, essentially like the central ones. In worn plumage, however, the exposed central pair becomes duller. In *viridigaster*, *cupreicauda* and *duidæ* freshly plumaged birds have the rump and upper tail-coverts widely fringed with ochraceous-tawny and all but the central rectrices narrowly tipped with cinnamon-rufous.

WALDRONIA, new genus

GENERIC CHARACTERS.—Resembling *Polytmus thaumantias* in the slenderness and curvature of the bill and feathering of the interramal space but tomia without a trace of serrations; rectrices broader, their tips obtuse, or bluntly pointed, rather than evenly rounded. Resembling *Smaragdites theresiæ*, but feathers on interramal space extending farther forward, tail more rounded; outer tail-feathers 8–10 mm. shorter than longest; the rectrices more pointed.

TYPE.—*Waldronia milleri*, new species.

Waldronia milleri, new species

SPECIFIC CHARACTERS.—General color green, all but central pair of rectrices broadly white basally and sharply and conspicuously tipped with white.

TYPE.—No. 245,918, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 4700 ft., Feb. 13, 1929; Olalla Bros.

DESCRIPTION OF MALE.—Crown greenish bronze; back and upper tail-coverts the same, but the feathers narrowly edged with glittering green, exposed part of central pair of rectrices deep glittering green with bronze reflections; remaining rectrices green, of same shade as the central pair, the outer pair snowy white for the basal half and terminal 4–5 mm.; the basal white increasing on the succeeding rectrices; the apical white narrower on the rectrices next the central pair, approximately the same in extent on the others; wing-quills and larger coverts purplish black, lesser and lower coverts and bend of the wing green; a small white postocular spot; throat and breast glittering green of much the same color as in *Polytmus thaumantias;* white bases of feathers more or less exposed on the throat and chin; abdomen more or less margined with white; lower tail-coverts bright green, the tips and base white; feet and bill black. 5 ♂: wing, 65–67; tail, 40–43; exposed culmen, 23–24 mm.

DESCRIPTION OF FEMALE.—Similar to male but underparts less solidly green, the basal white of the feathers more evident. 5 ♀: wing, 62–65; tail, 39–42; exposed culmen, 23–24 mm.

SPECIMENS EXAMINED

Waldronia milleri.—VENEZUELA: Mt. Duida, 4200 ft., 1♂; 4700 ft., 8 ♂, 9 ♀; 6600 ft., 3 ♂, 4 ♀.

Polytmus thaumantias.—21.

Smaragdites theresiæ.—11.

This species bears a general resemblance to the male of *Polytmus thaumantias* in both its general color and the pattern of the tail, but the absence of tomial serrations and the similiarity of the sexes are pronounced differences.

I have dedicated both this genus and species to the memory of my late associate, Mr. Waldron DeWitt Miller, in whose death this museum has sustained an irreparable loss.

Lophornis pavoninus duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Lophornis pavoninus pavoninus* Salvin and Godman, of the Merumé and Roraima Mts., British Guiana, but adult male with black vertical crown-stripe about half as wide, anteriorly narrower, rather than as wide as, or wider, than the culmen; the black throat washed with green to the base of the mandible; female with the feathers of the throat not margined with black laterally, the sides with little or no green.

TYPE.—No. 245,920, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 4700 ft.; Feb. 8, 1929; Olalla Bros.

SPECIMENS EXAMINED

Lophornis pavoninus duidæ.—VENEZUELA: Mt. Duida, 4700 ft., 1 ♂, 1 ♀; 5000 ft., 1 ♀.

Lophornis pavoninus pavoninus.—BRITISH GUIANA: Mt. Roraima, 3000 ft., 3 ♂ ad.; 1 ♂ im.; 1 ♀ (all but one ♂ ad. in Mus. Comp. Zoöl.).

The constancy of the differences between Guiana and Duida birds shown by our specimens is further indicated by descriptions of *pavoninus*

pavoninus which I have consulted. All of them speak of the black throat of the male, the streaked throat and green sides of the female.

Trogon personatus duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Agrees with *Trogon personatus roraimæ* Chapman, of the Subtropical Zone on Mt. Roraima, and differs from the Andean races of *prersonatus* in having the central rectrices deep coppery bronze, but differs from *roraimæ* in having the three outer pairs of rectrices more narrowly marked with white, the inner portion of the inner webs of at least the second and third pairs mottled, not definitely barred with white.

TYPE.—No. 245,923, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, alt. 2250 ft.; Dec. 20, 1928; Olalla Bros.

SPECIMENS EXAMINED

Trogon personatus duidæ.—VENEZUELA: Mt. Duida, 2250 ft., 2 ♂, 1 ♀; 4200 ft., 3 ♂; 5000 ft., 1 ♂.

Trogon personatus roraimæ.—VENEZUELA: Mt. Roraima, 5000–6800 ft., 3 ♂.

Trogon personatus personatus and *personatus assimilis.*—VENEZUELA: Mérida region, 2 ♂. COLOMBIA AND ECUADOR, 9 ♂, 9 ♀.

The relationships of this race are evidently with the Roraiman instead of Andean forms. Its occurrence at as low an altitude of 2250 feet is exceptional for a subtropical species on Duida. We have also found *Trogon collaris collaris* at our 2250-foot camp and as high as 5000 feet.

Aulacorhynchus derbianus duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Aulacorhynchus derbianus whitelyanus* (Salvin and Godman) of the mountains of British Guiana, but upperparts and particularly tail, yellower green, the central rectrices more broadly tipped with chestnut.

TYPE.—No. 245,924, Amer. Mus. Nat. Hist.; ♂ ad.; Aguita, alt. 3250 ft., Mt. Duida, Venezuela; January 2, 1929; Olalla Bros.

SPECIMENS EXAMINED

Aulacorhynchus derbianus duidæ.—VENEZUELA: Mt. Duida, 2250 ft., 1; 2700 ft., 1; 3250 ft., 7; 4700 ft., 5.

Aulacorhynchus derbianus whitelyanus.—VENEZUELA: Mt. Roraima, 4000–4200 ft., 2.

Aulacorhynchus derbianus derbianus.—Eastern ECUADOR, 5.

This species is apparently a representative of *A. d. derbianus* of the Subtropical Zone of eastern Ecuador and eastern Peru. The Duida form has the broader tail tip of the Ecuador bird and is thus, to this extent, intermediate between true *whitelyanus* and *derbianus*. In the greener tail it differs from either, in other respects it agrees with *whitelyanus* and differs from *derbianus* in having the maxilla redder, no blue nuchal band (though some specimens show a trace of blue on the nape), while the faint tinge of blue below is on the breast instead of at the posterior margin of the throat-patch, which is not so pure white.

Taraba major duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Resembling *Taraba major semifasciatus* (Cabanis) of the Tropical Zone of northeastern south America, including the region at the base of Mt. Duida, but bill averaging larger, the wing longer, the tail apparently always longer; the female darker above, the sides of the head blackish, the breast grayer and usually with black shaft-streaks; sides of the throat more or less washed and indistinctly barred with blackish. 4 ♂: wing, 97–99; tail, 84–87 mm. 5 ♀: wing,, 93–95; tail, 82–88 mm.

TYPE.—No. 245,925, Amer. Mus. Nat. Hist.; ♀ ad.; Mt. Duida, 6200 ft., Venezuela; Jan. 18, 1929; Olalla Bros.

SPECIMENS EXAMINED

Taraba major duidæ.—VENEZUELA: Mt. Duida, 4700 ft., 1 ♂, 1 ♀; 4800 ft. 1 ♂; 5000 ft., 1 ♂; 5200 ft., 1 ♂; 5500 ft., 1 ♂; 6200 ft., 2 ♀; 6600 ft., 1 ♂, 1 ♀.

Taraba major semifasciata.—VENEZUELA: base of Mt. Duida, alt. 325 ft.; 2 ♂, 3 ♀. Adequate series of this and other races.

Specimens from the base of Mt. Duida average slightly larger than others from elsewhere in the range of *semifasciata,* but in other respects agree with that race. Females of *transandeana* from throughout the greater part of its range approach *duidæ* in their blackish loral, ocular, and aural regions. I recall no previous records of *Taraba major* from above the Tropical Zone. Its ascent to the Subtropical Zone on Duida and evolution into a well-marked race is a particularly interesting demonstration of the origin of an upper zonal form from a contiguous basal ancestor.

Myrmothera simplex duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Closely resembling *Myrmothera simplex simplex* Salvin and Godman of Mt. Roraima but wash on breast, sides and flanks more rufescent, less olivaceous and heavier; the tarsi longer, 45 instead of 40 mm.

TYPE.—No. 245,926, Amer. Mus. Nat. Hist.; ♂ ad.; Central Camp, 4800 ft., Dec. 28, 1928; G. H. H. Tate.

SPECIMENS EXAMINED

Myrmothera simplex duidæ.—VENEZUELA: Mt. Duida, 4800–6200 ft., 12.

Myrmothera simplex simplex.—VENEZUELA: Mt. Roraima, 5000–6000 ft., 2.

Myrmothera simplex is apparently a representative of *Myrmothera companiosoma* of the Tropical Zone of northern South America, east of the Andes. In the color of the upperparts it is nearest, indeed closely resembles, *M. c. companiosoma* of the Guianas and southward, but the breast is gray, unstreaked, and the mandible terminally black.

RORAIMIA, new genus

GENERIC CHARACTERS.—A member of the subfamily Margarornithinæ; tail strongly graduated, outer pair of feathers 35 mm. shorter than longest; rectrices 12, all acuminate, the central feathers sharply pointed, the shaft, in some specimens, nearly denuded for its terminal 3 or 4 mm.; wing about equal to tail in length, fourth and fifth primaries (from without) longest, the outer about 13 mm. shorter than second (from without); hind-toe with claw as long as middle toe with claw; culmen decurved. In color, combining some of the characters of *Margarornis* and *Premnoplex;* wing without a shoulder-patch; its coverts of the same color as quills externally.

TYPE.—*Synallaxis adusta* Salvin and Godman.

Roraimia adusta, the single species belonging to this genus, has hitherto remained in the genus *Synallaxis* in which it was placed by its original describers, but its possession of twelve, instead of ten, rectrices shows that in this respect it is nearer to *Cranioleuca.* It differs, however, from that genus, as well as from *Synallaxis,* in its strongly developed claws and particularly long hind toe. In the latter character, as well as in the shape of the rectrices and certain color characters, it agrees with *Premnoplex* and *Margarornis* and while not typical of this group is apparently to be placed in it rather than with the Synallaxinæ. The bill resembles that of typical *Cranioleuca* but the characters presented by the toes and tail and the pattern of coloration prohibit its being placed in that genus. The middle toe and claw are slightly shorter, instead of being slightly longer than the tarsus as in typical Margarornithinæ, but this character is not constant in that group. In short, while having no structural characters that are distinctively its own, this species is so unlike any known bird that we cannot speak with certainty of its exact relationships and hence cannot even speculate on its origin as a member of the Roraima-Duida fauna.

MEASUREMENTS

Sex	Culmen	Wing	Tail	Tarsus	Middle Toe and Claw	Hind Toe and Claw	Claw
♂	15.5	61	59	21	19	19	7.5 mm.
♂	16.	68	67	21	20	19	8.
♀	16.	64	64	21	17.5	18	7.
♀	16.	61	59	22	19.	19	8.

Mecocerculus nigrifrons, new species

SPECIFIC CHARACTERS.—Not closely related to any known species; nearer in color to the *stictopterus* group, in proportions, to the *setaphagoides* group; a broad black band across the forehead.

TYPE.—No. 245,928, Amer. Mus. Nat. Hist.; ♂ ad.; Savanna Hills, Mt. Duida tableland, 4400 ft., Venezuela; February 11, 1929; G. H. H. Tate.

DESCRIPTION (sexes alike in color).—A broad, black band across the forehead bordered anteriorly by white, antrorse, nasal bristles; crown gray or neutral gray; an indistinct white line extends from the forehead over the eyes; back oil-green; wings and tail fuscous margined externally with oil-green; greater and lesser coverts broadly tipped with greenish white; wing-lining white tinged with greenish; underparts grayish white obscurely streaked on the throat and breast; center of abdomen whiter; flanks, ventral region and under tail-coverts tinged with greenish yellow; feet and bill black. 3 ♂: wing, 61.5, 64, 66; tail, 60, 63, 63; tarsus, 20, 21, 22; culmen, 14, 14, 14 mm. 2 ♀: wing, 54, 56; tail, 53, 54; tarsus, 17.5, 18; culmen, 13, 13 mm.

SPECIMENS EXAMINED

Mecocerculus nigrifrons.—VENEZUELA: Mt. Duida, 4200 ft., 2 ♂, 2 ♀; 4400 ft., 1 ♂; 4700 ft., 1 ♀.

Specimens of remaining species of genus (except *M. minor*).

This species differs from the known species of *Mecocerculus* not only in color but in its combination of characters and may deserve generic distinction. While more nearly resembling the gray-headed members of the genus in color, in having the wing and tail of nearly equal length it is more like *setaphagoides;* while the rictal bristles are more highly developed and the primaries narrower than in either.

Euscarthmornis duidæ, new species

SPECIFIC CHARACTERS.—A member of the *Euscarthmornis margaritaceiventer-impiger* group but rectrices wider, tail somewhat more rounded; not closely re-resembling any described species; upperparts practically uniform; throat and breast streaked; posterior underparts warm buff to pale orange-yellow.

TYPE.—No. 245,929, Amer. Mus. Nat. Hist.; ♂ ad.; Chorrera de Vegas, 4700 ft., Mt. Duida; Feb. 14, 1929; Olalla Bros.

DESCRIPTION OF MALE.—General tone of upperparts olive-fuscous, the crown darker, the rump more olive; tail fuscous externally margined with yellowish olive; wings fuscous; the coverts tipped, the inner quills margined with olive-buff; bend of the wing slightly yellower; under wing-coverts cream or maize; an ill-defined grayish loral stripe; throat white, obscurely streaked with grayish, the streaks ending in a dusky breast area; remainder of underparts warm buff to pale orange-yellow, the sides and flanks washed with dusky olive; feet brownish; maxilla brownish black; mandible browner. 5 ♂: wing, 55–56; tail, 44–47; tarsus, 21; culmen, 14.5–15 mm.

DESCRIPTION OF FEMALE.—Resembles the male in color but is slightly smaller. 5 specimens: wing, 49–54; tail, 37–41; tarsus, 18.5–20; culmen, 14–14.5.

SPECIMENS EXAMINED

Euscarthmornis duidæ.—VENEZUELA: Mt. Duida, 4700 ft., 6 ♂, 4 ♀; 5000 ft., 2 ♂, 2 ♀; 6200 ft., 2 ♂; 6600 ft., 2 ♂, 2 ♀.

Euscarthmornis margaritaceiventer-impiger group. Adequate series.

The characters of this species are too distinctive to afford a clue to its immediate ancestry. The group to which it seems nearest is apparently not represented in the Guianas.

Elænea tyleri, new species

SPECIFIC CHARACTERS.—Most nearly resembling *Elænea dayi* Chapman, of Mt. Roraima, but colors throughout less saturated, the breast and sides tea-green and vetiver-green rather than citrine-drab; size generally larger, the tarsi and bill longer.

TYPE.—No. 245,927, Amer. Mus. Nat. Hist., ♀ ad.; Mt. Duida, Venezuela; 5000 ft.; January 11, 1929; Olalla Bros.

DESCRIPTION (sexes alike in color).—Upperparts dark grayish olive to olivaceous-black, the crown and tail darker than back; all but outer pair of rectrices narrowly margined externally with olivaceous and, in fresh plumage, all narrowly tipped with whitish; wings of approximately the same color as tail; the median and greater coverts broadly tipped with grayish white; the tertials externally margined with the same color or the color of the flanks; bend of wing and under wing-coverts much like flanks; throat and breast tea-green, paler on the throat; sides and flanks and lower tail-coverts yellower (vetiver-green); center of abdomen pale yellow (chartreuse-yellow); feet and bill black.

SPECIMENS EXAMINED

Elænea tyleri.—VENEZUELA: Mt. Duida, 4200 ft., 1; 4400 ft., 7; 5000 ft., 4; 5500 ft., 2; 6200 ft., 6; 6600 ft., 4; 7100 ft., 2.

Elænea roraimæ.—VENEZUELA: Mt. Roraima, 1 (type).

While this bird is evidently a representative of *Elænea dayi*, its marked differences, both in color and size, from that species warrant its recognition as a full species. The relationships of *dayi* to other members of the group were discussed in connection with its description.[1]

It is a pleasure to dedicate this exceptionally interesting new bird to Mr. Sidney F. Tyler, Jr., whose coöperation made possible the expedition on which it was secured.

MEASUREMENTS

	Sex	Wing	Tail	Tarsus	Culmen	Longest Primary Longer Than Innermost
Elænea dayi						
Summit Roraima	♀	91	89	22	15	11 mm.
Elænea tyleri						
Duida, 4400 ft.	♀	93	89	24	17.5	12 mm.
" 5000 ft.	♀	94	89	24	17.5	11
" 6600 ft.	♀	95	92	25	17.5	11.5
" 4700 ft.	♂	99	93	26.5	17.5	10
" 5000 ft.	♂	99	94	27	18	12
" 6000 ft.	♂	101	93	27	17	11

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[1] 1929, Amer. Mus. Novitates, No. 341, p. 3.

Myiochanes fumigatus duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—In general tone of color resembling *Myiochanes fumigatus ardosiacus* (Lafresnaye) but smaller, tail darker and with the outer vane of the outer pair of feathers fully as dark as the inner vane. 2 ♂: wing, 86, 88; tail, 75. 2 ♀: wing, 82, 85 tail, 71, 72 mm.

TYPE.—No. 245,930, Amer. Mus. Nat. Hist.; ♂; Mt. Duida, Venezuela, 4400 ft.; February 9, 1929; G. H. H. Tate.

SPECIMENS EXAMINED

Myiochanes fumigatus duidæ.—VENEZUELA: Mt. Duida, 4200 ft., 1; 4400 ft., 1; 4700 ft., 2.

Myiochanes fumigatus ardosiacus and *M. f. zarumæ.*—Adequate topotypical series (see Amer. Mus. Novit., No. 138, 1924, p. 4).

Myiochanes f. cineraceus.[1]—VENEZUELA: Cerro del Avila (topotype), 1; Cumbre de Valencia, 1; Lagunita de Aroa, 4.

This is doubtless the form recorded from Roraima and Twek-quay, British Guiana by Chubb[2] as *Horizopus ardesiacus.* Hellmayr[3] states that two worn Guianan specimens are inseparable from *M. f. zarumæ,* a resemblance doubtless due to the condition and age of the skins. The four Duida birds are darker than *zarumæ,* the abdomen, as in typical *ardosiacus,* being practically as dark as the breast. While the character of a whitish outer vane on the outer pair of rectrices is most highly developed in *cineraceus* it is by no means wanting, at least on the outer margin of the vane, in topotypical *ardosiacus.* In *duidæ,* however, there is not even the slightest indication of paling on this vane.

Chloropipo uniformis duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Closely resembling *Chloropipo uniformis uniformis* Salvin and Godman, of the higher mountains of British Guiana, but color throughout brighter, yellower; size slightly smaller; the bill narrower.

TYPE.—No. 245,931, Amer. Mus. Nat. Hist.; ♂ ad.; Savanna Hills, 4400 ft., tableland of Mt. Duida, Venezuela; February 2, 1929; G. H. H. Tate.

SPECIMENS EXAMINED

Chloropipo uniformis duidæ.—VENEZUELA: Mt. Duida, 3250 ft., 2 ♂; 4200–4400 ft., 3 ♂; 4700 ft., 2 ♂, 3 ♀; 5000–5800 ft., 1 ♂, 2 ♀; 6200 ft., 1 ♂, 2 ♀.

Chloropipo uniformis uniformis.—VENEZUELA: Mt. Roraima, 4 ♂, 6 ♀.

A very close representative of *Chloropipo uniformis,* which heretofore has been known only from Roraima, Merumé, Twek-quay, and Kamarang, British Guiana.

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[1] Coll. Carnegie Mus.

[2] 1921, Birds Brit. Guiana, II, p. 224.

[3] 1927, Field Mus. Pub. No. 242, p. 202.

MEASUREMENTS

	No.	Sex	Wing	Tail	Breadth of Bill at Base
Chloropipo u. duidæ	5	♂	76–81	52–53	5–6 mm.
" " *uniformis*	4	♂	80–82	51–56	6.7
" " *duidæ*	5	♀	75–77	49–51	5 6
" " *uniformis*	5	♀	78–79	51–52	6.7

Troglodytes duidæ, new species

SPECIFIC CHARACTERS.—Resembling *Troglodytes rufulus* Cabanis of Mt. Roraima but adult with the underparts white, lores gray, bars on tail and inner wing-quills more pronounced; juvenal, Prout's brown instead of mummy-brown above; underparts distinctly barred black and white.

TYPE.—No. 245,933 Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, 4500 ft.; Dec. 27, 1928; G. H. H. Tate.

DESCRIPTION OF ADULT MALE.—Upperparts uniform argus-brown; lores and orbital ring gray; broad postocular patch same color as crown bordered above, behind, and below by ochraceous-buff to ochraceous-tawny; rectrices darker than back, finely and evenly barred with black; remiges, like tail, the outer webs of all but outer quill, both webs of inner quills, finely barred with brown and black; underparts white; flanks, ventral region and under tail-coverts slightly lighter than the back; feet and bill brownish black; gonys paler. 5 ♂: wing, 55–59; tail, 37–41; culmen, 17–17 5 mm.

DESCRIPTION OF ADULT FEMALE.—Resembles the male in color, but averages slightly smaller. 5 ♀: wing, 54–47; tail, 37–38; culmen, 16–17.

DESCRIPTION OF JUVENAL.—Upperparts uniform Prout's brown; postocular paler than in adult; sides of the head darker; wings and tail externally the color of the back, less definitely barred than in adult; underparts white, the feathers tipped with black giving an evenly barred appearance; sides, flanks, ventral region and lower tail-coverts somewhat duller than in adult; feet and bill brownish black; gonys paler.

SPECIMENS EXAMINED

Troglodytes duidæ.—VENEZUELA: Mt. Duida, 3250 ft.; 1 ad., 1 juv.; 4700–5000 ft., 5 ad., 1 juv; 5200–5800 ft., 2 ad.; 6200–6700 ft., 4 ad., 2 juv.; 7100 ft., 2 ad., 1 juv.

Troglodytes rufulus.—VENEZUELA: Mt. Roraima, 20 ad., 6 juv.

The bird here described is obviously a representative of *Troglodytes rufulus* of Mt. Roraima. I am led to give it specific rank less by the differences between the adults than by the even more pronounced differences shown by the young. These, it seems to me, argue for a more fundamental and significant variation than is indicated by the differences of degree which separate the mature birds. In any event, it is worthy of special note that the adults are more nearly alike than are the young. In spite of their much larger size these two species are near enough to *Troglodytes solstitialis* of the Andean humid Temperate Zone from western Venezuela to Argentina to suggest the possibility of their representing that species.

Microcerculus duidæ, new species

SPECIFIC CHARACTERS.—Most closely related to *Microcerculus ustulatus* Salvin and Godman, of Mt. Roraima, but much larger and less brightly colored, the prevailing color of the underparts buckthorn brown, rather than amber brown.

TYPE.—No. 245,932, Amer. Mus. Nat. Hist.; ♂ ad.; 6700 ft., tableland Mt. Duida, Venezuela; January 23, 1929; Olalla Bros.

DESCRIPTION (sexes alike in color).—Upperparts ruddy Brussels brown, the feathers of the crown very narrowly margined with black, such margins barely perceptible on the back, tail and wings, and their coverts blackish all strongly margined with argus brown; breast buckthorn brown, the throat paler and grayer the remaining underparts increasing to cinnamon or Brussels brown on the flanks and ventral region; the abdominal region usually with posteriorly rounded black bars which in some specimens extend to the breast and in others are nearly absent; lower tail-coverts obscurely barred; feet brownish black; maxilla black; mandible yellowish except at the extremity.

SPECIMENS EXAMINED

Microcerculus duidæ.—VENEZUELA: Mt. Duida, 3250 ft., 1 ♀; 4200 ft., 2 ♂, 1 ♀; 4700 ft., 2 ♂, 1 ?; 5000 ft., 1 ♀; 6700 ft., 1 ♂.

Microcerculus ustulatus.—VENEZUELA: Mt. Roraima, 1 ♂.

While differing markedly in both color and size from *M. ustulatus* of Mt. Roraima, the Duida bird is nearer to that species than to any other known form and doubtless represents it.

MEASUREMENTS

	Wing	Tail	Tarsus	Culmen
Microcerculus duidæ, 3 ♂	61–63	31–33	27–28	18.5–19 mm.
" *ustulatus*, 1 ♂	55	28	24	18
" *duidæ*, 3 ♀	57–59	29–30	25–26	18 –19

Turdus roraimæ duidæ, new subspecies

SUBSPECIFIC CHARACTERS.—Resembling *Turdus roraimæ roraimæ* Salvin and Godman in color, but wings and bill averaging longer, tail constantly longer, the bill darker.

TYPE.—No. 245,934, Amer. Mus. Nat. Hist. ♂ ad.; Mt. Duida, alt. 6200 ft., Venezuela; Jan. 15, 1929; Olalla Bros.

SPECIMENS EXAMINED

Turdus roraimæ duidæ.—VENEZUELA: Mt. Duida, 3250 ft., 1 ♀, 1 juv. (Jan. 1); 4700 ft., 2 ♂; 5000 ft., 4 ♂, 2 ♀, 1 juv.; 5500 ft., 2 ♂, 1 ♀; 6200 ft., 4 ♂, 3 ♀.

Turdus roraimæ roraimæ.—VENEZUELA: Mt. Roraima, 5000 ft., 6 ♂; 6800 ft., 3 ♂.

Measurements of Males

	Wing	Tail	Culmen	Depth of Bill at Base
Turdus duidæ	128	110	27	7 mm
" "	130	110	28	7 7
" "	122	103	27	7
" "	125	102	25	7
" "	125	107	26.5	7.3
" "	125	115	28	7.3
" "	126	106	25	7.3
" "	129	107	26	7 3
" "	133	119	28.5	7.3
" *roraimæ*	122	95	26	6
" "	124	95	26	6
" "	117	97	27	6.3
" "	126	95	26	6
" "	119	90	25	6
" "	123	99	26.3	6
" "	121	95	26.5	6.3

While the differences between Duida and Roraima specimens are slight they are constant enough to be diagnostic and hence call for recognition through nomenclature.

Myioborus duidæ, new species

Specific Characters.—Related to *Myioborus castaneicapillus* Cabanis of Mt. Roraima, but with the underparts orange instead of lemon-chrome and with a conspicuous white supraloral stripe.

Type.—No. 245,925, Amer. Mus. Nat. Hist., ♂ ad.; Central Camp, 4800 ft., Mt. Duida, Venezuela; Dec. 31, 1928, G. H. H. Tate.

Description (sexes alike).—Upperparts dark grayish olive, more olive in fresh, grayer in worn plumage; crown and nape chestnut; forehead and lores blackish gray; auriculars gray; a well-defined white superciliary stripe from the bill to behind the eye; rectrices black, three outer pairs of feathers with terminal white areas occupying about half the outer pair and a half-inch shaft-wedge on the third pair, outer vane of second pair narrowly black; wings fuscous-black, their coverts slightly grayer; bend of the wing and lower coverts white; chin whitish, rest of underparts orange; lower tail-coverts white faintly tinged with orange; tibiæ grayish; feet and bill brownish black. 5 ♂: wing, 66–69; tail, 60–64; culmen, 7.5–8 mm.

Specimens Examined

Myioborus duidæ.—Venezuela: Mt. Duida, 3250 ft., 2; 4700 ft., 10; 4800–5000 ft., 12; 6200 ft., 2; 6700 ft., 1.

Myioborus castaneicapillus.—Venezuela: Mt. Roraima, 15.

Myioborus brunneiceps.—Bolivia, 14. Argentina, 9.

The Duida and Roraima species are evidently mutually representative. The pigmental change which makes the yellow of the latter the orange of the former is doubtless less important biologically than the somewhat pronounced result would indicate. There is, however, no variation in the color of the underparts in our large series of both species. One set is uniformly yellow, the other uniformly orange. The white superciliary is always present in *duidæ* and often wholly absent in *castaneicapillus;* but in some specimens of the latter it is suggested as a faint, grayish supraloral stripe.

Emberizoides duidæ, new species

SPECIFIC CHARACTERS.—Larger and markedly darker than any other member of the genus; the tail largely black; wings narrowly margined with olive-green.

TYPE.—No. 245,937, Amer. Mus. Nat. Hist., ♂ ad.; Savanna Hills, Mt. Duida, Venezuela; 4400 ft.; February 2, 1929; G. H. H. Tate.

DESCRIPTION OF ADULT (sexes alike).—Upperparts largely black, the crown narrowly, the back more widely margined with Dresden brown or Saccardo's umber; the scapulars with a suggestion of Saccardo's olive, rump and upper tail-coverts dark Dresden brown narrowly striped with black; lateral pair of rectrices fuscous, remaining rectrices black or blackish narrowly margined externally with grayish or brownish; wings black or blackish; the primaries narrowly margined with greenish olive, the wing-coverts more widely margined with a more greenish olive; bend of the wing yellow, under wing-coverts white; lores whitish, eye-ring white, the sides of the head blackish gray; throat and center of the abdomen white; breast and sides washed with light brownish olive, the flanks and under tail-coverts more Saccardo's umber and centrally streaked with black; feet brownish; maxilla black; mandible primuline-yellow.

SPECIMENS EXAMINED

Emberizoides duidæ.—VENEZUELA: Mt. Duida, Savanna Hills, 4400 ft., 2 ♂; 4700 ft., 1 ♂; 5100 ft., 1 ♂; 6700 ft., 1 ♀.

Emberizoides herbicola sphenurus.—VENEZUELA: Esmeralda, 325 ft., 22; Savanna Grande, near Esmeralda, 330 ft., 25; Halfway camp, 350 ft., 10; base of Duida, 725 ft., 1; Mt. Roraima, 4000–6000 ft., 13; Cotiza, near Caracas, 5; Bermudez, 2; Mérida region 2. COLOMBIA: San Miguel, Santa Marta, 1; Bogotá, 2; Cauca Valley, 2.

Emberizoides herbicola herbicola.—BRAZIL: Bahia, 1; Rio de Janeiro, 2; Itatiaya, 1600 ft., 3. ARGENTINA: Misiones, 3.

This striking zonal race was found only on the tableland of Duida in open growths of bromelias. It is obviously a representative of *Emberizoides herbicola* from the northern form of which, *sphenurus,* it has apparently been derived. Although this race is common on the savannas at the base of Duida, its range is separated from that of *duidæ* by wide areas of forest. This fact, in connection with the degree of differentiation presented by *duidæ,* induces me to describe it as a species.

MEASUREMENTS

	Sex	Wing	Tail	Tarsus	Culmen
E. duidæ					
Mt. Duida, 4400 ft.	♂	81	118	26	16.5 mm
" 4400 ft.	♂	81	119	26.5	17.5
" 6700 ft.	♀	75	111	25.5	16.5
E. herbicola sphenurus					
Base of Mt. Duida, 350 ft.	♂	69	92	25.5	15.5 mm
" " "	♂	66	88	25	15.5
" " "	♂	67	88	25	16
" " "	♂	68	92	25.5	15
" " "	♂	67	92	25	15
" " "	♀	66	94	24	14.5
" " "	♀	65	89	24	15.5
" " "	♀	65	85	24	14.5
" " "	♀	63	84	24	15
" " "	♀	64	87	22.5	15
E. h. herbicola					
Rio de Janeiro	♂	75	109	25.5	17 mm.
"	♀	72	99	24	16.5

Atlapetes duidæ, new species

SPECIFIC CHARACTERS.—Most closely related to *Atlapetes personatus* (Cabanis) of Mt. Roraima, but throat and breast chestnut instead of yellow; back, wings and tail black instead of dark gray.

TYPE.—No. 245,936, Amer. Mus. Nat. Hist.; ♂ ad.; Cerros de Savanna, 4700 ft., tableland, Mt. Duida, Venezuela; February 27, 1929; Olalla Bros.

DESCRIPTION (sexes alike).—Head and neck, throat and breast chestnut; back, wings and tail jet black; bend of the wing yellow; lower breast and abdominal region empire-yellow; sides, flanks, and under tail-coverts olive-citrine, the latter margined with yellow; feet and bill black. 5 ♂: wing, 79–81; tail, 80–85; tarsus,.27–29; culmen, 16–17 mm.

SPECIMENS EXAMINED

Atlapetes duidæ.—VENEZUELA: tableland of Mt. Duida, 4800–6200 ft., 10 ♂, 2 ♀.
Atlapetes personatus.—VENEZUELA: Mt. Roraima, 11 ♂, 7 ♀.

Evidently a specifically distinct representative of the Roraiman *Atlapetes personatus*. Some specimens of the latter have traces of chestnut on the breast showing a tendency toward the development of the marking that distinguishes *duidæ*.

Diglossa duidæ, new species

SPECIFIC CHARACTERS.—Not closely resembling any known species; slightly larger than *Diglossa humeralis*, back slate-color, underparts paler; lower tail-coverts gray.

TYPE.—No. 245,938, Amer. Mus. Nat. Hist.; ♂ ad.; Mt. Duida, Venezuela, 6600 ft.; January 23, 1929; Olalla Bros.

Description (sexes alike).—Crown shining black, the feathers slightly outlined by their somewhat brighter margins; changing into deep slate-color on the back and upper tail-coverts; tail and wings black very narrowly margined with slate-color; greater and median wing-coverts black usually narrowly margined with slate-color, but sometimes (about one in every three specimens) both greater and median coverts tipped with white; lesser wing-coverts slate-gray of the same color as the back, and not forming a distinct area; lower wing-coverts grayish; chin and sides of the head black, the breast slate-color, changing to slate-gray on the abdomen where the darker margin of the feathers gives a slightly squamate effect; lower tail-coverts slate-gray margined with whitish; tibiæ somewhat darker than abdomen; feet blackish; bill dark plumbeous, blacker apically. 5 ♂: wing: 71–75, tail, 54–47; culmen, 15–16 mm. 5 ♀: wing 67–70; tail, 52–55; culmen, 14–15 mm.

Specimens Examined

Diglossa duidæ.—Venezuela: Mt. Duida, 550 ft., 2; 3250 ft., 2; 4700 ft., 25; 5000-5500 ft., 10; 6000–6700 ft., 10.

Examples of all the remaining species of the genus.

In view of the close affinity between the bird-life of Mts. Duida and Roraima it is surprising to find the Duidan representative of *Diglossa* so unlike *Diglossa major* of Roraima. In its large size, disproportionately long tail (only 8–10, instead of 15–18 mm. shorter than wing), pronounced shaft-streaks and chestnut lower tail-coverts, *major* differs so widely from *duidæ* that the two birds do not appear to be in even the same group.

On the whole, *duidæ* most nearly resembles *D. humeralis* of the Temperate Zone of the east Andes in Colombia. This species is slightly smaller than *duidæ* and is wholly black except for the gull-gray lesser wing-coverts, slate-gray rump and, usually, trace of gray in the lower tail-coverts. The gray lesser wing-coverts are much more pronounced than in *duidæ* in which they are nearly of the same slate-color of the back, but, with this exception, an increase of black in *duidæ* would cancel the differences between it and *humeralis.* In the absence of a distinct lesser wing-covert area *duidæ* resembles *nocticolor*, the Santa Martan representative of *humeralis.*

AMERICAN MUSEUM NOVITATES

Number 381
Published by
The American Museum of Natural History
New York City
Nov. 2, 1929

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A COLLECTION OF AMPHIBIANS AND REPTILES FROM THE MISSISSIPPI VALLEY, WITH FIELD OBSERVATIONS

By Charles E. Burt and May Danheim Burt

The amphibians and reptiles reported here were obtained by the authors in the Middle West during June and July, 1929, and have been deposited in the collection of The American Museum of Natural History. Specimens were taken in many states, but the most interesting and important series were secured in isolated sections of South Dakota, Nebraska, Texas and Louisiana. This work places on record our field observations on habitat and habits, makes the locality data obtained available to students of distribution, and is a part of our program to advance the knowledge of the distribution, habitat and habits of the amphibians and reptiles of the United States. During our first expedition (1928) we collected in the area west of the Mississippi River, particularly in the Southwest, and the results obtained have been prepared for publication. Many of our recent observations on habitat and habits involve the same species and, if presented here, would be merely a duplication of our previous account, or those of others. Therefore, since we have endeavored to present new facts, our discussion pertaining to certain forms is necessarily limited. Likewise, we have removed locality records from our list when they have been found identical with previous reports. We regard a "spot record" as an addition to a mere county report and, therefore, as a necessary and helpful advance over the less concise "county-system" of presenting locality data.

SALAMANDERS

Triturus viridescens viridescens (Rafinesque)

The water form of this subspecies was found to be very abundant 4 miles east of Cadiz, Trigg County, Kentucky, where it was readily secured by dragging a dip net through the aquatic vegetation of a shallow pool.

Ambystoma texanum (Matthes)

Many larvæ of this form were secured in company with those of *Triturus viridescens viridescens* mentioned above. They, too, were in the shelter of aquatic débris.

Desmognathus fuscus fuscus (Rafinesque)

Dr. R. H. Painter has given us two small examples which he found under moist leaves at the edge of a spring near Old Man's Cave, Hocking County, Ohio, on May 29, 1925.

TOADS

Bufo americanus Holbrook

Our representatives of this form were all taken in July. The young were often found in the daytime on the banks of creeks and ponds and the adults were usually collected at night, chiefly from the road or from lawns.

Kansas: specimens were obtained 4 miles south of Cherryvale, Montgomery County.

Missouri: 6 miles east of Wentzville, St. Charles County.

Illinois: at Nashville, Washington County.

Kentucky: 9 miles northeast of Murray, Calloway County; 2 miles south of Sedalia, Graves County; 1 mile northeast of Hodgenville, 3 miles north of Hodgenville and 9 miles northeast of Hodgenville, Larue County; 10 miles south of Paducah, McCracken County; and 4 miles east of Cadiz, Trigg County.

West Virginia: St. Albans, Kanawha County; and 6 miles east of Hurricane, Putnam County.

Virginia: 5 miles east of Luray, Page County; and 2 miles west of Sperryville, and at Washington, Rappahannock County.

Bufo compactilis Wiegmann

This toad was taken in Texas at night after a rain. It was found 1 mile south of Wallis, Austin County; and 3 miles east of Eagle Lake, Colorado County.

Bufo terrestris Bonnaterre

Certain of our toads from western Louisiana, eastern Texas and southwestern Arkansas are doubtfully referred to this species to which they seem structurally nearer than to any other. It may be of interest that here the call is strikingly "goat-like" instead of a trill as in *americanus*, *woodhousii* and eastern *terrestris*.

At night in early July adults were often heard calling from ponds in southwestern Louisiana and southwestern Arkansas, and during the day young were occasionally found in woods, hopping about in damp places.

Louisiana: specimens were secured 6 miles north of Lake Charles, Calcasieu County; 6 miles north of Hornbeck, Sabine County; and 3 miles north of Leesville, Vernon County.

Texas: 6 miles northwest of Atlanta, Cass County.

Arkansas: 5 miles north of Mena, Polk County.

Bufo valliceps Wiegmann

This is a very common toad in parts of eastern Texas. After a rain on July 4, it was singing from roadside ditches, which were filled with water. Specimens were collected at Sugarland, Fort Bend County; 1 mile south of High Island, Galveston County; 3 miles northeast of Crosby, Harris County; and on the gravel in front of the steps of the main building of the San Marcos Academy, at San Marcos, Hays County.

Bufo woodhousii Girard

Each year hundreds of these toads come from the temporary pools of certain sections in the sand hills of northern Nebraska. After leaving the water, small individuals often hop about on the hot sand, even at midday. Thus, on July 20, several dozens were collected near shallow ponds in Holt County. Elsewhere, young *Bufo woodhousii* are usually found on mud banks near ponds or streams where they are more protected from the heat of the sun and from drying out. It seems apparent that the sand-hill phase of this species is much more resistant to drying than the ordinary phase.

Louisiana: specimens were found 6 miles south of Vinton, Calcasieu County.

Texas: 14 miles east of Eagle Lake, Colorado County; 2 miles northwest of Denton, Denton County; 1 mile west of Orchard, Fort Bend County; 5 miles south of Austin, and 11 miles south of Austin, Travis County; and 8 miles north of Georgetown, Williamson County.

Kansas: 2 miles south of Lost Springs, Marion County; and 2 miles north of Cleburne, and 7 miles north of Randolph, Riley County.

Nebraska: 2 miles east of Brunswick, Antelope County; Bristow, and 4 miles west of Butte, Boyd County; 2 miles south of Kearney on the left bank of the Platte River, Buffalo County; 7 miles northeast of Chambers, 2 miles southwest of Martha, O'Neill, and south bank of the Niobrara River at the Bristow Dam, Holt County; 4 miles northwest of Red Cloud, Webster County; and 1 mile northeast of Cumminsville, Wheeler County.

FROGS

Acris gryllus (Le Conte)

Cricket-frogs were in full song at night during both June and July, especially after showers. A clasping pair was captured 10 miles south of Fort Worth, Texas, on the evening of June 30.

Arkansas: specimens were obtained 5 miles north of Mena, Polk County; and 12 miles south of Lockesburg, and at De Queen, Sevier County.

Illinois: 4 miles south of Carbondale, Dowell, and 2 miles south of Elksville, Jackson County; 1 mile south of Tamaroa, Perry County; and 2 miles north of Anna, and 7 miles south of Anna, Union County.

Kentucky: 4 miles southeast of Horse Cave, Hart County; 2 miles west of Cadiz, and 4 miles east of Cadiz, Trigg County; and 8 miles east of Bowling Green, Warren County.

Louisiana: 6 miles south of Vinton, 4 miles east of Edgerly, and 2 miles northeast of Lake Charles, Calcasieu County; and 6 miles north of Hornbeck, Sabine County.

Missouri: 12 miles east of Boonville, Boone County; 7 miles west of Williamsburg, Calloway County; 4 miles east of Boonville, Cooper County; 15 miles east of Sweet Springs, Saline County; and 6 miles east of Wentzville, St. Charles County.

Nebraska: on the south bank of the Niobrara River at the Bristow Dam, northern Holt County; and 1 mile south of Loup City, Sherman County.

Oklahoma: Kaola, Haskell County; Page, and 1 mile north of Hodgen, Le Flore County; 5 miles north of Thackerville, Love County; 3 miles north of Davis, Murray County; 1 mile west of Keefton, Muskogee County; 4 miles north of Delaware, Nowata County; 4 miles northwest of Claremore, Rogers County; and 4 miles north of Wagoner, Wagoner County.

Texas: 4 miles west of Luling, Caldwell County; 1 mile west of Columbus, Colorado County; Valley View, Cooke County; 2 miles northwest of Denton, Denton County; 4 miles east of Engle, and 2 miles west of Flatonia, Fayette County; 1 mile west of Orchard, and 1 mile north of Sugarland, Fort Bend County; 8 miles west of San Marcos, and 1 mile east of Wimberly, Hays County; 2 miles south of Burleson, Johnson County; Liberty, and 5 miles east of Devers, Liberty County; 5 miles south of Waco, McLennan County; 8 miles north of Fort Worth, and

10 miles south of Fort Worth, Tarrant County; and 8 miles north of Austin, 5 miles south of Austin, and 11 miles south of Austin, Travis County.

Hyla cinerea cinerea (Schneider)

On the evening of July 7 five of these beautiful frogs were found singing in the vicinity of a prairie pool 2 miles northeast of Lake Charles, Calcasieu County, Louisiana.

Hyla triseriata Wied

"*Pseudacris*" was collected only in Kansas, Nebraska, and South Dakota. In the first two states adults were taken only at night. These were in full song during the first three weeks of July, frequenting the numerous roadside ponds which are common in the prairie region. In South Dakota, however, adults were collected in the daytime near prairie ponds in what appeared to be a favorable habitat for *Acris gryllus*, which, however, was not found. Here in South Dakota a live *Pseudacris* was removed from the mouth of a garter snake, *Thamnophis radix*, and two additional frogs were found in stomachs examined. Thus, the garter snake is to be listed among the enemies of *Hyla triseriata*.

At Brocksburg, Nebraska, numerous young were emerging from the water of a rather large, shallow pond on the afternoon of July 18. Adults were not observed.

Kansas: specimens were found 5 miles north of Cherryvale, and 7 miles south of Morehead, Montgomery County; and 2 miles southeast of Barnes, Washington County.

Nebraska: 2 miles north of Brocksburg, Keyapaha County; and 9 miles south of Loup City, Sherman County.

South Dakota: 7 miles west of Okaton, Jones County; and at Reliance, Lyman County.

Noble (1923) is followed in regarding *Pseudacris*, as at present defined, as a synonym of *Hyla*.

Hyla versicolor versicolor (Le Conte)

All of our specimens of this subspecies were taken at night while they were singing. We found them in many positions: some on trees, some in bushes, some in vegetation, and others on the ground, usually in the vicinity of water. They were always unusually active at night after a shower, particularly in the flooded areas.

Arkansas: a series was obtained 5 miles north of Mena, Polk County.

Kentucky: 3 miles north of Hodgenville, Larue County.

Louisiana: 6 miles north of Lake Charles, Calcasieu County.

Texas: 1 mile south of High Island, Galveston County.

West Virginia: 6 miles east of Hurricane, Putnam County; and 1 mile west of St. Albans, Kanawha County.

Rana areolata (Baird and Girard)

Two individuals were secured from the pavement 13 miles east of Eagle Lake, Colorado County, Texas, just after an evening shower.

Rana catesbeiana Shaw

Bullfrogs were taken in Illinois, 2 miles south of Elkville, Jackson County; 7 miles south of Anna, Union County; and 7 miles southeast of Beaucoup, and at Nashville, Washington County.

Kentucky: 9 miles west of Murray, Calloway County; 4 miles southeast of Horse Cave, Hart County; and 4 miles east of Cadiz, Trigg County.

Missouri: 12 miles east of Boonville, Boone County; and 6 miles west of Sweet Springs, Saline County.

Nebraska: 2 miles west of Ericson, Wheeler County.

Texas: 2 miles southwest of Dayton, Liberty County.

Rana clamitans Latreille

The green frog was found in southern Illinois in the vicinity of the deeper ponds where there was a protection of reeds and sedges. Specimens were taken 4 miles south of Carbondale, Jackson County; and 7 miles south of Anna, Union County.

Rana pipiens Schreber

All of our specimens of the leopard-frog are apparently of the same species. We are unable to separate southern examples as *Rana sphenocephala*. The white spotting on the tympanum, emphasized by some authors as characteristic of the latter species, occurs not only in part of our southern series but also in representatives from Nebraska and South Dakota.

Arkansas: specimens were secured 4 miles north of Texarkana, Miller County.

Illinois: 4 miles south of Carbondale, and Dowell, Jackson County; and 2 miles north of Anna, and 7 miles south of Anna, Union County.

Kentucky: La Center, Ballard County; 12 miles northeast of Murray, Calloway County; and 4 miles east of Cadiz, Trigg County.

Louisiana: 15 miles north of Longville, Beauregard County; 6 miles south of Vinton, Calcasieu County; and 6 miles north of Hornbeck, Sabine County.

Missouri: 12 miles east of Boonville, and 7 miles west of Williamsburg, Boone County; 4 miles east of Boonville, Cooper County; 20 miles east of Kansas City, and 5 miles northeast of Oak Grove, Jackson County; Concordia, and 15 miles east of Sweet Springs, Lafayette County; Mineola, Montgomery County; and 6 miles east of Wentzville, St. Charles County.

Nebraska: 2 miles south of Kearney on the left bank of the Platte River, Buffalo County; Valentine, Cherry County; O'Neill, and 2 miles southwest of Martha, Holt County; 2 miles north of Brocksburg, Keyapaha County; 4 miles northwest of Red Cloud, Webster County; and 6 miles north of Bartlett, Wheeler County.

Oklahoma: Sapulpa, Creek County; 2 miles north of Mulhall, Logan County; 5 miles north of Thackerville, Love County; 12 miles north of Perry, Noble County; 9 miles northwest of Claremore, Rogers County; and 4 miles north of Wagoner, Wagoner County.

South Dakota: Belvidere, Jackson County; Lyman, Lyman County; 6 miles north of Hermosa, Pennington County; and Pine Ridge, and 6 miles north of Pine Ridge, Shannon County.

Texas: 2 miles south of Belton, Bell County; 1 mile northwest of Atlanta, Cass County; 13 miles east of Eagle Lake, Colorado County; 2 miles west of Flatonia, Fayette County; Sugar Land, and 1 mile west of Orchard, Fort Bend County; 4 miles west of San Marcos, 8 miles west of San Marcos, and 1 mile east of Wimberly, Hays County and 8 miles north of Fort Worth, Tarrant County.

LIZARDS

Anolis carolinensis Voigt

The young of this species was found 6 miles south of Vinton, Calcasieu County, Louisiana, on July 5. Other specimens were taken from trees and bushes 4 miles east of Edgerly, Calcasieu County; and 3 miles north of Leesville, Vernon County, Louisiana.

Crotaphytus collaris (Say)

A female found on the red soil of Logan County, Oklahoma, was remarkably reddish in color, and the body was covered by an unusually large number of orange spots.

Oklahoma: specimens were secured 16 miles south of Ardmore, Carter County; and 2 miles north of Mulhall, Logan County.

Kansas: 2 miles northwest of Cleburne, Riley County.

Holbrookia maculata maculata (Girard)

Spotted swifts are very common in the sand hills of Nebraska. Specimens were taken at Bristow, Boyd County; 3 miles west of Nenzel, Cherry County; 2 miles south of the Bristow Dam on the Niobrara River, northern Holt County; and 10 miles south of Minden, Kearney County.

Six females collected on June 29, were found to contain egg sets of five, six, six, six, six, and seven respectively.

Sceloporus undulatus undulatus (Latreille)

Young of the pine-lizard were found on July 5 in Calcasieu County, Louisiana.

Arkansas: specimens were taken 4 miles north of Texarkana, Miller County; and 3 miles southwest of Mena, Polk County.

Louisiana: 8 miles north of Longville, Beauregard County; 4 miles east of Edgerly, and 6 miles south of Vinton, Calcasieu County; 6 miles north of Hornbeck, Sabine County; and 3 miles north of Leesville, and 5 miles south of Leesville, Vernon County.

Texas: 5 miles southwest of Texarkana, Bowie County, and 1 mile northwest of Atlanta, Cass County.

Sceloporus undulatus thayerii (Baird and Girard)

At Pine Ridge, South Dakota, a special search was made for topotypes of *Sceloporus garmani* Boulenger, but without success. However, southeast of Pine Ridge, in Cherry County, Nebraska, specimens were found which fit in every way the description of *garmani*. These are indentical with *Sceloporus undulatus thayerii* as it exists in western Kansas, the dark brown dorsal spots and the yellow lateral lines usually being very distinct.

Specimens were collected 19 miles west of Merriman, and 2 miles west of Crookston, in the sand hills of Cherry County, Nebraska. Here individuals showed a tendency to congregate in the vicinity of rose bushes where they found shelter in tunnels among the roots.

Phrynosoma cornutum (Harlan)

Horned lizards frequent the highways of Oklahoma and Texas and are often seen by travelers.

Oklahoma: we took specimens 4 miles north of Perry, and 1 mile south of Perry, Noble County.

Texas: Troy, Bell County; 3 miles south of Denton, Denton County; 2 miles north of Hillsboro, Hill County; and 3 miles south of Grandview, Johnson County.

Cnemidophorus sexlineatus sexlineatus (Linnæus)

This subspecies is found in the drier pine woods of the lower Mississippi Valley as well as in more open, sandy or rocky places.

Louisiana: it was secured 15 miles north of Longville, Beauregard County; and 5 miles south of Leesville, Vernon County.

Arkansas: 2 miles north of Ashdown, Little River County.

Texas: 1 mile northwest of Atlanta, Cass County.

Nebraska: Riverton, Franklin County; and 4 miles northwest of Red Cloud, Webster County.

Cnemidophorus sexlineatus gularis (Baird and Girard)

Intergrades between this form and the typical *Cnemidophorus sexlineatus sexlineatus* were found in Oklahoma, 5 miles north of Thackerville, and at Thackerville, in Love County.

Typical representatives of *gularis* were collected in Hays County, Texas, 8 miles west of San Marcos, and 1 mile east of Wimberly.

Leiolopisma laterale (Say)

Very young examples of the brown-backed skink were found 6 miles south of Vinton, Calcasieu County, Louisiana, on July 5. Adults were taken in Arkansas, 4 miles north of Texarkana, Miller County, and 12 miles south of Lockesburg, Sevier County.

Eumeces fasciatus (Linnæus)

A medium sized, orange-throated representative of the species was obtained 3 miles north of Leesville, Vernon County, Louisiana.

Eumeces obsoletus (Baird and Girard)

A sonoran skink was found under a flat prairie rock 7 miles south of Marion, Marion County, Kansas.

Eumeces septentrionalis (Baird)

Two excellent examples of this beautiful form were taken from under flat pieces of tin in a dump along the highway 2 miles south of Kearney, Buffalo County, Nebraska. Here they were on the left bank of the Platte River.

SNAKES

Heterodon contortrix (Linnæus)

All of our examples of this species were taken in moderately rocky areas where some sand was present. Specimens were collected at Bristow, Boyd County, Nebraska; and Kittanning, Armstrong County, Pennsylvania.

Heterodon nasicus Baird and Girard

A representative of this form was found dead in the road 3 miles south of Ord, Valley County, Nebraska. Corn was growing in the sandy soil on both sides of the road bed.

Another example was taken at the edge of the Badlands, 6 miles northwest of Scenic, Pennington County, South Dakota.

In a previous report, the senior author (1927, p. 5) called attention to the probability of the occurrence of *Heterodon nasicus* in Riley County, Kansas, but did not include the form in the county faunal list. Since that time Gloyd (1928, p. 44) has reported it from the county with the statement that the specimen upon which his record was based (collected in 1923 by a student) could not be found. Recently an old faded example, collected near Manhattan by Professor E. A. Popenoe, was located by Mr. Gloyd in an overlooked assortment of jars in the Museum of the Kansas State Agricultural College. This specimen, secured for the American Museum through an exchange, may henceforth serve as material evidence for the existence of *Heterodon nasicus* in Riley County.

Coluber constrictor flaviventris (Say)

The blue-racer is common in the prairies of the Middle West. It was taken in the Badlands of South Dakota at Interior, Jackson County, and 6 miles west of Interior; also in Nebraska, 1 mile northeast of Valentine, Cherry County; and in Oklahoma at Wister, Le Flore County.

Specimens of this form from De Soto County, northwestern Louisiana, are not unicolor above but are prominently spotted with ashy gray. Therefore, they have become known locally as the "ash snake." We obtained an example 5 miles north of Frierson in the grass at the edge of the woods.

Masticophis flagellum flavigularis (Hallowell)

A large adult was found sunning itself on a log in a relatively open forest 5 miles west of Harwood, Gonzales County, Texas.

Elaphe obsoleta confinis (Baird and Girard)

This subspecies was obtained near a pile of rocks on the bank of a small stream at Columbus, Colorado County, Texas; and in the woods 6 miles south of Vinton, Calcasieu County, Louisiana.

Pituophis sayi (Schlegel)

Bull-snakes are most active during the cooler portions of the day, but they continue to move about after dark.

Kansas: specimens were taken 4 miles north of Belleville, Republic County; and 3 miles west of Barnes, Washington County.

Nebraska: 9 miles west of Butte, Boyd County; and 3 miles west of Norden, Keyapaha County.

South Dakota: 7 miles south of Hot Springs, Fall River County; and in the Badlands, 1 mile east of Imlay, Pennington County.

Texas: 6 miles north of Georgetown, Williamson County.

Lampropeltis calligaster (Harlan)

A prairie king-snake was secured near a field of grass 9 miles north of Perry, Noble County, Oklahoma.

Natrix grahamii (Baird and Girard)

Several of these graceful water-snakes were found under a board near a pond 12 miles north of Perry, Noble County, Oklahoma.

Natrix rhombifera (Hallowell)

This species frequents the muddier ponds of southeastern Texas. In one instance three large adults were obtained in an automobile tire which was floating on the water. Specimens were secured at Sugarland, Fort Bend County; and at Raywood, Liberty County, Texas.

Natrix sipedon sipedon (Linnæus)

Representatives of this form where found under rocks about the edges of streams in Missouri. They were taken 12 miles east of Boonville, in Boone County; and 7 miles west of Williamsburg, Calloway County.

Natrix transversa (Hallowell)

Specimens were obtained near ponds 3 miles north of Tonkawa, Kay County, Oklahoma; 2 miles south of Belton, Bell County, Texas; and 8 miles north of Austin, Travis County, Texas.

Thamnophis radix (Baird and Girard)

These garter-snakes are very abundant in South Dakota, particularly in the vicinity of prairie ponds. Here, near Reliance, they were found to be feeding on the frog, *Hyla triseriata.*

Nebraska: specimens were taken 13 miles west of Merriman, Cherry County; 2 miles north of Gordon, Sheridan County; 3 miles north of Hebron, Thayer County; and 5 miles northeast of Ord, Valley County.

South Dakota: 6 miles south of Pukwana, Brule County; 7 miles west of Okaton, and Draper, Jones County; and at Reliance, Lyman County.

Thamnophis sauritus proximus (Say)

Ribbon-snakes were found in marshy situations in the woods 6 miles south of Vinton, Calcasieu County, Louisiana.

Thamnophis sirtalis sirtalis (Linnæus)

A common eastern garter-snake was found near a pond 6 miles east of Wentzville, St. Charles County, Missouri. A moderate amount of red on its sides suggested the western subspecies, *Thamnophis sirtalis parietalis.*

In 1925 the senior author took examples of this subspecies in a grassy meadow at Fort Snelling, Hennepin County, Minnesota. One is being deposited in the collection of the American Museum.

Tantilla gracilis Baird and Girard

The sand-snake was taken in Oklahoma at Ardmore, Carter County; and at Sapulpa, Creek County.

Agkistrodon mokasen Beauvois

A copperhead, found dead in the road after dark on the evening of July 6, was freshly killed and had evidently been active about sundown. Woods were on each side of the road. The locality was 14 miles southeast of Atlanta, Cass County, Texas.

Agkistrodon piscivorus (Lacépède)

In a swamp, under a small pine log near the edge of a pool of water 3 miles east of Vidor, Orange County, Texas, a water mocassin was secured.

Sistrurus catenatus catenatus (Rafinisque)

This form was taken at Kimball, Erie County, Ohio.

Crotalus confluentus confluentus (Say)

A live rattlesnake was found on the road near a wheat field in the vicinity of Sparks, Cherry County, Nebraska.

TURTLES

Chelydra serpentina (Linnæus)

A snapping turtle was obtained at the margin of a prairie pond 2 miles northwest of Denton, Denton County, Texas.

Terrapene carolina triunguis (Agassiz)

This form was obtained in Oklahoma at Delaware, Nowata County, and 8 miles east of Claremore, Rogers County.

Terrapene ornata (Agassiz)

This common box-turtle of the Middle West is most active in the early morning on hot summer days.

Nebraska: specimens were secured at Bristow, Boyd County; and 2 miles south of the Bristow Dam, northern Holt County.

Oklahoma: 4 miles south of Norman, Cleveland County; and 6 miles north of Oklahoma City, Oklahoma County.

Texas: 14 miles north of Austin, Travis County.

Graptemys pseudogeographica pseudogeographica (Gray)

This turtle was collected 12 miles northeast at Shreveport, Caddo County, Louisiana.

Chrysemys belli belli (Gray)

Painted turtles were obtained 12 miles north of Columbia, Boone County, Missouri; 1 mile south of the Bristow Dam, northern Holt County, Nebraska; and 6 miles south of Pukwana, Brule County, South Dakota.

Chrysemys picta (Schneider)

This species was found in a pool 2 miles west of White Sulphur Springs, Greenbrier County, West Virginia.

Pseudemys elegans (Wied)

Small specimens of this turtle were obtained from Kentucky ponds, with a dip net, 4 miles east of Cadiz, Trigg County; and 8 miles east of Bowling Green, Warren County.

Pseudemys texana Baur

A medium-sized individual of this species was trapped in a drain ditch from the road, 1 mile west of Orchard, Fort Bend County, Texas

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AMERICAN MUSEUM NOVITATES

Number 382

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

Nov. 4, 1929

59.7, 55 J: 15.5

CERTAIN EFFECTS IN THE HABITS OF SCHOOLING FISHES, AS BASED ON THE OBSERVATION OF *JENKINSIA*

By C. M. Breder, Jr.

INTRODUCTION

The fact that *Jenkinsia stolifera* (Jordan and Gilbert) nearly always occurs in large, densely compacted schools is well known, and while this habit is typical of practically the entire family Clupeidæ, it is especially well marked in this particular species. Further, the permanent small size of the individuals and their tendency to keep in shallow water close to shore make them better suited to observation than most other clupeids. Such schools have been observed by numerous naturalists.

OBSERVATION

Dr. E. W. Gudger[1] records certain characteristics of their behavior as observed by him at the Tortugas Laboratory of the Carnegie Institution of Washington some years ago, without attempting an explanation of the phenomenon. Similar behavior was observed by the writer at the same place during the season of 1929. The present paper is devoted to an attempt to explain certain features of this behavior in purely mechanistic terms. The entire statement of Gudger follows, with its accompanying figure (Fig .1).

> These little fishes were found in great schools, numbering probably millions. They were especially abundant on the lee side of Loggerhead Key and around our wharf. They often hover over gray snappers, which seem to feed on them. However, the snappers either excite little fear in the herrings or else possess a great fascination for them. The little fish collect around them in dense swarms, resembling a swarm of bees, leaving a clear space immediately around the snapper about equal to his length, as shown in Plate 1, figure 7. Whenever the snapper moves, the rather orderly swarm breaks up into a mob, which quickly rearranges itself when the big fish comes to rest. The little fish are in motion all the time, but the swarm remains fairly constant in size and shape.

This observation was fully confirmed by the writer at the old government wharf at Garden Key, and in addition it was noted that Gudger's "clear spaces" occurred under the conditions listed below.

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[1] 1929. 'On the Morphology, Coloration and Behavior of Seventy Teleostean Fishes of Tortugas, Florida,' Carnegie Instit. Wash., Pub. 391, pp. 149–204.

1. Clear spaces occurred over any fish dark enough to show in contrast to the white sand forming the bottom.
2. Clear spaces occurred over any dark object sufficiently dark or near enough to the surface to be distinctly visible. These included rocks, large shells, pieces of iron pipe and other submerged objects.
3. Clear spaces occurred about piles and tie-rods of the wharf itself which emerged from the surface of the water.

In all cases, an identical distance was left about each object, irrespective of its size or shape. The shadow of objects entirely out of the water, such as the dock itself, had little, if any, effect on the formation of these schools (Fig. 2).

It was noted that this condition obtained when the water was crystal clear, and at such times inshore schools were observed to hover over only the white sandy bottoms. At other times, when the water was turbid, as after a storm, the schools were found to occur over any type of bottom, without discrimination. At night the schools disappeared, moving offshore, or more likely, simply dispersing, as some individuals could always be attracted to a submerged light.

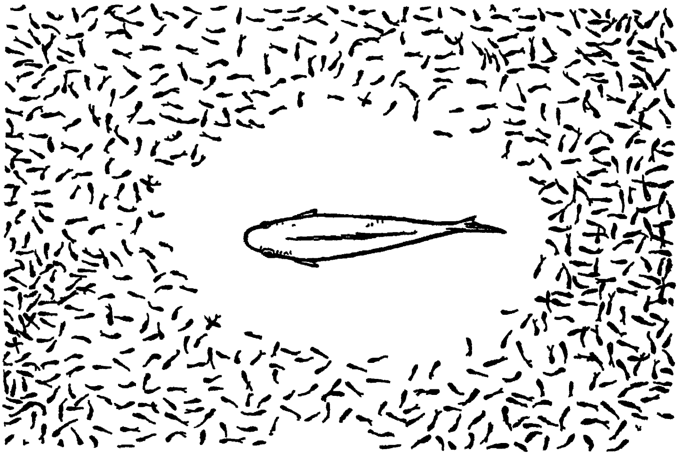

Fig. 1. "Showing swarm of *Jenkinsia stolifera* around and above the gray snapper, *Neomænis griseus*, but leaving a clear space immediately over the snapper." (After Gudger.)

The fishes are shown in an irregular arrangement in this drawing, whereas it is the nature of the fishes to arrange themselves in orderly files.

INTERPRETATION

The interpretation of these reactions is made on a basis of experiments carried out at the New York Aquarium on various schooling fishes by A. E. Parr.[1] In his paper it is demonstrated that the schooling of the pelagic fish (*Scombrus colias*) is controlled by a visual reaction. When two such fishes come within each other's visual range, they approach until just about far enough apart to avoid interference with each another, swimming from then on in a parallel fashion. If some disrupting influence turns the advance members of such a school back on itself, a "milling" is set up in which the school continues in a circular or elliptical path until some further disruption upsets it. This is clearly set forth by Parr, and supported by good experimental evidence. *Jenkinsia* clearly shows schooling habits of this type, and owing to its habitat, such schools are constantly being deflected and consequently are usually "milling" about for the most part. These deflections are due mainly to shallowing water, rocks, piles, and the excursions of predatory fishes.

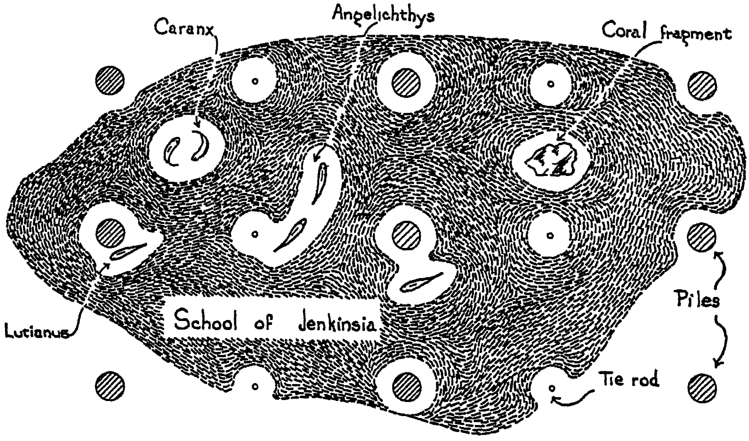

Fig. 2. Diagram of school of *Jenkinsia* based on observations made at the government dock at Garden Key.

Due to the numerous interfering objects, the school of necessity forms into "eddies" or "whorls" about each.

To this proposition of Parr we would add another to the effect that such fishes that depend on visual reactions for the formation of schools approach no closer to any other object than that at which it becomes clearly visible to them. It should be evident that this positive reaction to fishes of a similar size and a negative reaction to any other objects completely explains the conditions described by Gudger and here amplified.

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[1] 1929. 'A Contribution to the Theoretical Analysis of the Schooling Behavior of Fishes,' Occ. Pap. Bingham Oceanographic Coll., No. 1, December, pp. 1–32.

This, of course, would give a measure of the visual ability of the species in question. Confirmatory to this is the fact that some object, such as a net handle, may be brought as close to the school as it habitually keeps from other objects without causing it to change its contour. Bringing it closer causes the school to re-form around it as about any other object. Such an experiment must be performed with great care and slowness, as a rapid movement causes an immediate scattering which is, of course, to be expected. The net handle moved rapidly at a much greater distance than the fishes approach a still object causes scattering. This is explained on the basis of the fact that an image moving across the retina is much more stimulating than a stationary one, i.e., it becomes "more" visible due to its movement. Doubtless differently colored objects would be approached to different distances dependent on their visibility. It so happened that all the objects noted were approximately of the same general tone. Experiments could be easily made to test the validity of this idea.

Young catfishes when still in schools, as Parr points out, remain only as far apart as their tactile barbels reach. This is also true of their approach to solid objects, as a glance in an early summer pond will demonstrate.

There is a temptation to try to reduce these two reactions to a single one, but it is not felt certain that this may be done successfully. We may tentatively assume that there is a tendency to maintain a certain retinal effect which is reached by approaching fishes of similar size at a given distance and other and darker objects at a greater distance. This would explain the two effects previously considered and also that of following larger fishes at a "respectful" distance. This may be prominently observed in schools of *Seriola* and *Naucrates* following much larger sharks. It is doubted, however, if such a viewpoint can be made to cover all the cases and it is simply set down as a suggestion. For the present it is probably better to consider the effect as the combination of a positive reaction to like individuals with a negative reaction to all other objects.

Larger predaceous fishes seem to take advantage of the "milling" of such fishes by swimming across an advancing front and turning it back on itself, after which the school remains more nearly stationary. Allen[1] describes such behavior in the case of *Alopias vulpes*. If this assumption is true it would appear that the excessively elongate caudal of *Alopias* functions efficiently in the rapid formation of a milling school. It would thus appear that this type of deflection would be much more efficient, in the light of Parr's work, than would be ordinarily supposed, reducing the tail action of *Alopias* and the milling of schooling fishes to two strictly bio-mechanical interacting reactions. Thus, it would be left unnecessary to assume a locomotor significance or a "maiming" value for the elongate tail, both of which seem to be questionable, while still this peculiar specialization would not be without function.

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[1] 1923. 'Behavior of the Thresher Shark.' Science, N.S., LVIII, No. 1489, July 3, pp. 31–32.

SUMMARY

1. *Jenkinsia* will not normally approach a dark, solid object closer than a certain distance, which is probably equal to its limit of visibility.
2. Schools of *Jenkinsia*, with their vacuities over and around solid objects, are interpreted in the mechanical terms of a positive mutual attraction of the fish for each other and a common negative reaction toward any other, generally dark, body.
3. It is possible that these effects might be reduced to different aspects of the same reaction.
4. Further study should throw light on the reactions of some pelagic fishes to larger objects in motion as well as the apparently "intelligent" rounding up by larger fishes of schools, reducing them to purely mechanical performances which would be, nevertheless, useful.

AMERICAN MUSEUM NOVITATES

Number 383 Published by The American Museum of Natural History New York City Nov. 4, 1929

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TWO NEW GENERA OF RODENTS FROM SOUTH AMERICA

By H. E. Anthony

The American Museum has been fortunate in the acquisition of mammal material from South America, and in recent years the collections from this region have been greatly increased. In identifying these specimens, undescribed forms are being discovered, and pending the more detailed final reports which will be published on the particular expeditions or localities of major importance, it is deemed advisable to give preliminary descriptions of the material new to science.

Among the many interesting mammals collected by Mr. G. H. H. Tate in northern Venezuela, in 1925, there are two specimens of fish-eating rat which represent a new genus. This capture considerably extends the eastern range of the group of which *Ichthyomys* is the best known member and rather hints that these rodents, difficult to trap and apparently nowhere abundant, may be much more widely distributed than we have hitherto imagined. The fact that the new rat calls for the erection of a genus is also suggestive, for this genus makes the fifth in the South American group of highly specialized, fish-eating rodents, and we are finding many intermediate characters to bridge over the gap from the generalized, terrestrial cricetines. Oddly enough, the first described genus of the group, *Ichthyomys*, is the most highly specialized in the characters of predatory dentition and of modified hind foot. *Anotomys* alone of the other genera has a comparable swimming organ in the broadly fringed foot; the three remaining genera of so-called fish-eating rats have the hind foot much narrower and less widely fringed with stiff hairs than in *Ichthyomys*. The new genus may be known as *Daptomys*.

DAPTOMYS, new genus (Cricetidæ)

DESCRIPTION.—A small rat of the so-called fish-eating group typified by *Ichthyomys* to which it is closely related. External form not highly modified for an aquatic habit; hind feet of normal proportions, not developed into broad swimming organs, marginal fringe of hairs scarcely discernible; ear small but noticeable; upper lip narrowly cleft (judging from dried skins); tail densely haired; pelage showing moderate aquatic specialization, composed of close underfur and hard, glistening guard-hairs. Skull most like that of *Ichthyomys;* rostrum broad and heavy; zygomatic arch incomplete; brain-case but slightly inflated; superior outline essentially a straight line; interparietal a very narrow strap-shaped element; supraorbital foramen opening laterally; incisors sharp and predatory in type, anterior faces of incisors slightly inclined toward each other; molar dentition very much as in *Ichthyomys* except for last molar which is somewhat smaller in upper jaw, decidedly smaller in the lower, and with only a rudiment of the posterior half of the pattern shown by *Ichthyomys;* bullæ inflated.

GENOTYPE.—*Daptomys venezuelæ*, new species.

Daptomys venezuelæ, new species

TYPE.—No. 69907, Amer. Mus. Nat. Hist.; ♂ ad.; Neveri, about 15 miles west of Cumanacoa, northern Venezuela; altitude 2400 feet; March 8, 1925; collector, G. H. H. Tate. The type is a skin in good condition accompanied by its skull and trunk skeleton.

GENERAL CHARACTERS.—About the size of *Ichthyomys hydrobates* of Merida, Venezuela, but differing conspicuously in size and development of hind foot, character and color of pelage, and in cranial characters; superficially resembling *Neusticomys monticolus* of the Ecuadorean Andes, with which it agrees in the degree of aquatic specialization of hind foot, character and color of pelage, and in some cranial characters, such as inflated bullæ and lateral position of supraorbital foramina, but differing from it in heavier built skull, broader rostrum, and less inflated brain-case.

DESCRIPTION.—Color above, uniform blackish brown, the tips of the long hairs glistening black and the pelage slate-colored at the base; sides of head and body slightly lighter in tone than back; underparts grizzled gray and slate-color, the tips of the long hairs silvery whitish; tail brownish black above and below, the hairs quite long and thick; toes of forefoot whitish, the rest of upper surface of forefeet clove-brown; hind feet above, hair-brown, sparsely haired.

Skull strongly built; rostrum thick and heavy; interorbital region with but little constriction, about as broad as rostrum; top of skull flat, nasals, frontals, and parietals forming a straight line in profile; supraorbital foramina opening laterally into orbit rather than upward as in *Ichthyomys;* brain-case but slightly rounded, showing very little inflation; zygomatic arch incomplete and reduced to mere thread just posterior to the orbit, where a short gap occurs; parietal a very narrow element, but with considerable transverse extent; bullæ moderately inflated and not pinched in anteriorly as in *Ichthyomys;* incisive foramina fairly long and broad, not quite reaching to plane of first molars; a noticeable pair of processes just anterior to and outside of the first upper molars, on the anterior zygomatic root; incisors slender, acutely pointed, their anterior faces slightly inclined toward one another; molars simple, last upper molar quite small, a mere peg, last lower molar with but one functional lamina or "cusp."

MEASUREMENTS.—Taken in the flesh: total length, 236 mm.; length of head and body, 131; tail vertebræ, 105; hind foot, 27. Skull, greatest length, 28.5; length of nasals, 10.2; breadth of rostrum just anterior to zygomatic root, 5.9; zygomatic breadth, 13.6; interorbital breadth, 5.4; breadth of brain-case, 12.9; incisive foramina, 4.7×2.0; length of upper molar series, 4.0; auditory bullæ, 5.3×4.7.

A COMPARISON OF THE FIVE KNOWN GENERA OF THE *Ichthyomys* GROUP

	Hind Foot	Character of Pelage	Ear	General Character of Skull	Last Lower Molar
Ichthyomys (Based upon 26 specimens)	Broad, heavily fringed with stiff hairs	Semi-hispid, long guard-hairs abundant	External ear small but functional conch present; bullæ not inflated	Strongly built, rostrum heavy, brain-case inflated laterally	Tooth divided into two easily distinguished subequal sections
Anotomys (3 specimens)	Ditto	Soft, guard-hairs comparatively few in number	External ear rudimentary, no functional conch; bullæ not inflated	Not so heavily built, rostrum more slender, nasals meeting frontals at an angle, brain-case inflated	Ditto. Posterior section about half as large as anterior
Daptomys (2 specimens)	Not very broad; marginal hairs weakly developed, scarcely visible	Fairly soft, guard-hairs not so abundant	Conch present and fairly conspicuous; bullæ inflated	Strongly built, rostrum heavy, brain-case rather small	Posterior section reduced to mere vestige
Rheomys (1 specimen)	Ditto. Hallux not reduced, tip of claw reaching beyond most posterior plantar tubercle	Ditto	Ditto	Not especially robust, rostrum slender (comparatively), brain-case moderately rounded	Posterior section reduced but $\frac{1}{3}$–$\frac{1}{2}$ as large as anterior section
Neusticomys (19 specimens)	Not broad, fringe weakly developed; hallux reduced, tip of claw not reaching to plane of most posterior plantar tubercle	Soft, guard-hairs inconspicuous	Ditto	Ditto	Posterior section reduced to vestigial cone

Daptomys appears to be intermediate between the highly specialized *Ichthyomys* and *Anotomys* on the one hand, and the more generalized *Rheomys* and *Neusticomys* on the other. Externally the new form is most like *Rheomys* and *Neusticomys;* indeed, on the basis of skins alone, the three might well be classed as congeneric. The skull of *Daptomys* has more in common with the skull of *Ichthyomys*, for the skulls of both these genera are much more heavily built than in the case of *Rheomys* and *Neusticomys.*

Among the mammals collected by Mr. G. H. H. Tate on the summit of Mt. Roraima, British Guiana, is a small series of a rodent which appears to be somewhat intermediate in character between *Akodon* and *Oxymycterus.* For this mouse the following new genus is proposed.

PODOXYMYS, new genus (Cricetidæ)

GENERAL CHARACTERS.—A mouse with the external appearance of a dark-colored *Akodon* and the skull of an *Oxymycterus.*

DESCRIPTION.—Claws of forefeet long and slender, slightly longer than those of hind feet; eye small; tail about as long as length of head and body; pelage long and lax. Skull long and slender, especially in anterior half; zygomatic plate narrow and with backward sloping anterior margin; interparietal very small; incisive foramina very long and reaching from just posterior of incisors well beyond plane of first molars.

GENOTYPE.—*Podoxymys roraimæ*, new species.

Podoxymys roraimæ, new species

TYPE.—No. 75586, Amer. Mus. Nat. Hist., ♀ ad.; summit of Mt. Roraima, British Guiana; altitude 8600 feet; November 27, 1927; collector, G. H. H. Tate. The type is a skin in good condition accompanied by its skull, and trunk in alcohol. The skull is in good condition except for slightly crushed interparietal region and fragments broken out midway on each jugal.

GENERAL CHARACTERS.—External appearance that of a dark-colored, long-tailed *Akodon*, with long, slender claws (which suggest the generic name); skull with long, slender rostrum, narrow zygomatic plate and general appearance of *Oxymycterus.*

DESCRIPTION.—Pelage long and lax, 10–11 mm. long on back, blackish slate at base and for most of the length of the hair, only the tip being colored. Above, finely mixed clay-color and blackish, the minute specks of color at the tips of the hairs being insufficient to dominate the black and the general impression resulting in a rather dark pelage; there is a tendency (shown by two out of five specimens) for the color pattern to be darkest on the rump, but otherwise the upperparts are fairly uniform; sides of head and underparts slightly lighter in tone than back; hands and feet clove-brown above; tail about half of total length, very sparsely haired, hair-brown above and below; ears of fair size but partially hidden in the long pelage; eye rather small; claws of forefeet long (third claw extending 3 mm. beyond pad), slender, strongly compressed laterally, slightly curved, those of hind feet a trifle shorter.

Skull long and slender, with marked resemblance to *Oxymycterus*. Rostrum elongate; interorbital region approximately parallel-sided, no trace of supraorbital beading, margins rounded; brain-case proportionally rather small, evenly rounded; zygomatic arches scarcely flaring beyond plane of brain-case, weak and thread-like at mid-point; interparietal greatly reduced, a mere slip; incisive foramina very long, narrow, and extending almost the entire length of the diastema, the posterior termination reaching well beyond plane of first molars; interpterygoid fossa broad; bullæ of moderate size, slightly inflated; dentition presenting no unusual features, m^1 with no notch on anterior face.

MEASUREMENTS.—Taken in the flesh: total length, 196 mm.; length of head and body, 101; tail vertebræ, 95; hind foot, 23. Greatest length of skull, 27.5; length of nasal, 11; zygomatic breadth, 12.3; interorbital breadth, 6; breadth of rostrum at mid-point, 4.2; breadth of brain-case, 11.5; incisive foramina, 7×2; length of diastema, 7; length of maxillary toothrow, 4 4.

There are five specimens in the series of *Podoxymys roraimæ*, all collected on the summit of Mt. Roraima. The topotypes agree with the type in all essential characters and about the only variation in color occurs in the amount of black on the rump, a very slight difference.

A small series of *Akodon ærosus*, topotypes, the species made the genotype of the subgenus *Chalcomys* by the late Oldfield Thomas when he worked out the relationships of the Muridæ commonly referred to *Akodon* (Ann. and Mag. Nat. Hist., 1916, p. 336), is selected as a basis for comparison between *Akodon* and *Podoxymys*. At first glance the skins appear to be very similar, but can be easily separated on the basis of the following characters: *Podoxymys* has noticeably longer and more slender claws (more especially on hands); pelage is distinctly longer and softer; and the tail is proportionally longer. In cranial characters the two genera have little in common, for *Podoxymys* has a much narrower, elongate skull, a different type of zygomatic plate, longer incisive foramina which are not narrowed posteriorly, and somewhat weaker dentition.

There are no species of *Oxymycterus* in the collection of the American Museum which are comparable in size and color with *Podoxymys roraimæ*, but in many characters *Oxymycterus* and *Podoxymys* resemble each other. The two are alike in the long, lax pelage but differ in the longer and more slender claws of *Podoxymys*. The skull of *Podoxymys* resembles that of *Oxymycterus* in being slender and elongate (although it shows this character in a more advanced degree than the latter), in the narrow and backwardly sloping zygomatic plate, in the parallel-sided and rounded interorbital region, and in the prolongation of the nasals beyond the plane of the incisors. The principal differences between the skulls of the two genera are the more elongate incisive foramina of *Podoxymys*, its more reduced interparietal, flatter superior profile, and lower, less falciform coronoid process on mandible.

AMERICAN MUSEUM NOVITATES

Number 384
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
Nov. 6, 1929

59.82 (469.9)

A COLLECTION OF BIRDS FROM THE AZORES

BY ROBERT CUSHMAN MURPHY AND JAMES P. CHAPIN

In the Ibis for 1923, pp. 44–49 and 190, Murphy reported upon a small collection of birds from the Azores, listing *Larus hyperboreus* and *Actitis hypoleucos* as additions to the known avifauna of the archipelago. The present notes relate to a more recent series of specimens obtained by the same collector, Mr. José G. Correia. These still further extend the large list of New World birds that have visited the Azores and also include new records for individual islands. As heretofore, the chief sources consulted have been the monographic paper by Hartert and Ogilvie-Grant (Novit. Zoöl., 1905, XII, pp. 80–128), and Dr. Hartert's 'Vögel der Paläarktischen Fauna.'

Mr. Correia's trip to the Azores was purely personal. It was made in order that he and his wife might revisit their old homes, at Fayal and Terceira respectively, after an absence of several years among the islands of the South Pacific Ocean. He took advantage, nevertheless, of the opportunity to observe and collect, and with such success that examples of thirty-five species of birds were sent by him to The American Museum of Natural History.

His notes and labels indicate that the localities and periods of field work were approximately as follows:

Fayal, Apr. 13–May 16; Terceira, May 17–June 14; Fayal, June 15–July 2; Pico, July 6–Aug. 31; Fayal, Sept. 1–Sept. 20; Terceira, Sept. 23–Oct. 31; San Miguel, Nov. 5–Nov. 27; Terceira, Nov. 28–Dec. 15; Fayal, Dec. 16–Jan. 15.

He left Boston, Mass., on April 7, 1927, and arrived at Horta, Fayal, on the 13th. Spring rains, then in progress, continued steadily for ten days, so that the soil was thoroughly soaked when he took to the field on the afternoon of April 23.

At this season considerable numbers of birds were distributed over the tilled land. Chaffinches were to be seen in large flocks in the fresh green fields; the blackbirds were more dispersed, although groups of as many as eight were sometimes together. Starlings seemed scarce, doubtless because their breeding period was already well under way. The canaries, too, had paired and were building nests. The female woodcocks were still incubating, and males alone appeared for short flights at evening. The best opportunity for collecting woodcocks of both sexes proved to be during the feeding time of early morning, but even then they seemed far less abundant than during the love-flight period of late February and March. The wood pigeons, which are likewise so conspicuous at certain seasons, were to be found only about sunrise. when they were resting in evergreen trees between the feeding hour and the return to the nest. During full daylight not one was to be seen.

During the voyage between Fayal and Terceira, in the middle of May, many thousands of the large Azorian shearwaters (*Puffinus kuhlii borealis*) were observed at sea, as well as a few small black petrels (*Oceanodroma*) near Graciosa, and examples of the Azorian gray-backed gulls in the vicinity of the ports. An islet off Graciosa was covered with a breeding colony of common terns.

At Terceira the land birds seemed peculiarly tame when compared with those of Fayal. The commonest Terceiran species proved to be the rock dove, and after this the blackbird. Chaffinches and canaries were numerous on the hillsides, and kinglets and wood pigeons were reported from the higher forests, although Correia did not personally observe them.

Returning to Fayal about the middle of June, he found the young birds of most species out of the nests and following their parents. The young starlings alone appeared to flock by themselves. Rock doves, starlings and quail were confined to the open country; woodcock and kinglets clung exclusively to the forests; all other species, according to his notes, were to be found more or less in country of either type.

On July 6 he journeyed to Pico, making camp on the south coast at a site that he had occupied six years earlier. Great destruction of the sea birds had apparently taken place in the interim, for but few terns and shearwaters were now to be found at breeding places formerly occupied by thousands. Native boys had carried away many shearwater eggs and chicks shortly before his arrival.

At Pico, as at Terceira, the rock dove and blackbird outnumbered all other terrestrial species. Collecting during July and August proved difficult, for most of the birds had withdrawn into brush country where they were silent and secretive. In the first week of September he returned to Fayal and made a special effort to secure young and moulting birds of the various species.

On September 23, Correia landed at Praia da Victoria, Terceira, remaining at the island through October and collecting many interesting residents and autumn migrants. Rainy and windy weather was the rule throughout this period. During the second week of October, flocks of northern shore birds began to arrive on the beaches, usually remaining only a day or two and then departing. Ducks, herons, grebes (including the North American pied-billed grebe), curlews, and brown-headed gulls were also among the migrants observed about the lake and marsh at Praia da Victoria. Later in the month flocks of goldfinches arrived at Terceira, possibly from another island, and the species soon became abundant.

On November 5, Correia began a three week's stay at San Miguel, where with the aid of the American Consul and Professor Antonio Silveira Vicente, curator of the museum at Ponta Delgada, he continued his successful field work and secured examples of the endemic bullfinch. This rare bird and the green finch (*Chloris chloris aurantiiventris*) were the only Azorian species that he observed exclusively at San Miguel.

On November 27, he once more sailed for Terceira, where he collected during two weeks of steady rainfall, before returning to Fayal. At the latter island he made a notable addition to the avifauna of the Azores by obtaining a snowy owl (*Nyctea*) on January 14.

Podilymbus podiceps (Linnæus)

Colymbus podiceps Linnæus, 1758, 'Syst. Nat.,' 10th Edit., I, p. 136 (Carolina).

A female taken at Terceira, October 24, 1927, constitutes the first record for the Azores. It is apparently a bird of the year.

Podiceps nigricollis nigricollis Brehm

Podiceps nigricollis Brehm, 1831, 'Handb. Naturg. Vög. Deutschland,' p. 963 (Germany).

A male taken at Terceira on September 24, 1927, was in winter plumage, and plainly adult, as it still shows a few lengthened straw-colored feathers in the ear-region.

Puffinus kuhlii borealis Cory

Puffinus borealis Cory, 1881, Bull. Nuttall Orn. Club, VI, p. 84 (near Chatham Island, Cape Cod, Mass.).

Native Name.—Cagarro.

Pico, July 9, 12, 25, 26, 1927. Some of these had large and some small gonads.

Figure 1 illustrates the size relationship of this race as compared with the typical Mediterranean form and the still smaller subspecies of the Cape Verde Islands.

Seven eggs taken from crevices along sea cliffs at Pico, on July 12, were all heavily incubated. They are white, though all more or less

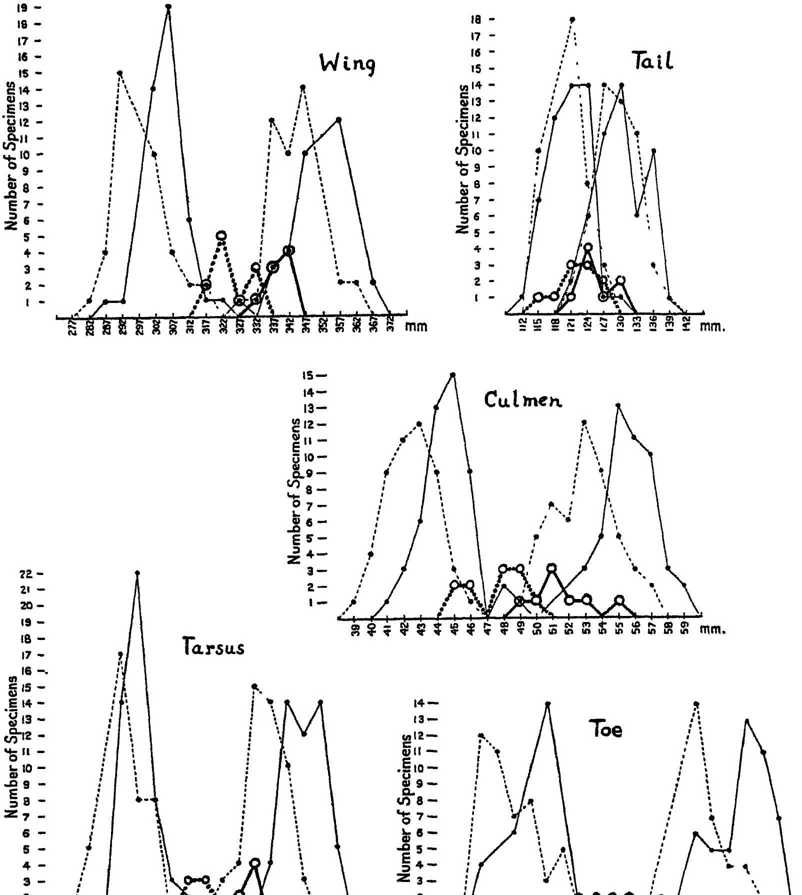

Fig. 1. Frequency distribution curves showing the variation and size relationship in three geographic races of *Puffinus kuhlii.* Solid lines represent males, dotted lines females. Left pair of graphs, 50 males and 50 females of *Puffinus kuhlii borealis* from Pico Island, Azores; middle pair of graphs (heavy), 9 males and 11 females of *Puffinus kuhlii kuhlii* from Majorca and Minorca, Balearic Islands; right pair of graphs, 50 males and 50 females of *Puffinus kuhlii edwardsi* from Razo and Brava, Cape Verde Islands.

The Mediterranean or typical subspecies is shown to be exactly intermediate in size between the Azorian and Cape Verde races. Discrepancy in the height of the graphs results from the fact that they are based upon measurements of 100 specimens of two races but only 20 of the third.

stained. The surfaces are rather evenly pitted with fine, pin-point depressions, and the form is highly variable. The measurements of the series are as follows: 73×50, 72×51.5, 76×50, 75×50, 75×49.5, 76×49, 74×50 mm.

In connection with the date and condition of the shearwater eggs from Pico, it may be well to refer to a series of downy young of the same species collected by Mr. Jesse Metcalf during the cruise of the yacht 'Wawaloam' at the Desertas and Salvages Islands in September and October, 1926. The youngest of eight specimens is a half-grown chick still completely covered with down, taken at Bugio on September 23. Another from the Desertas, dated September 19, is appreciably more advanced, as the down has been moulted from most of the dorsal surface. The others, dated at Gran Salvage October 3–8, are nearly full-grown, though much down still clings to their breasts and bellies. One of these is an isabelline specimen, with white down tinged with fawn-color, and with contour feathers of a very pale brownish-gray.

Ardea cinerea cinerea Linnæus[1]

Ardea cinerea Linnæus, 1758, 'Syst. Nat.,' 10th Edit., I, p. 143 (Europe; restricted type locality, Sweden).

Native Name.—Arêlo.

Terceira, October 11; Fayal, October 15, 1927.

No specimen in the series is fully adult. Since Ogilvie-Grant saw the species at Flores and Graciosa in April, it probably breeds in the Azores.

Branta bernicla bernicla (Linnæus)

Anas Bernicla Linnæus, 1758, 'Syst. Nat.,' 10th Edit., I, p. 124 (northern Europe).

An immature female taken on the lake at Furnas, San Miguel, on November 16, 1927, constitutes the first record from the Azores. This individual is in the light-bellied plumage, and is very small, with a wing of only 305 mm.

Buteo buteo rothschildi Swann

Buteo buteo rothschildi Swann, 1919, 'Synopt. List Accipitres,' part 2, p. 48 (Azores).

Native Name.—Milhafre.

Fayal, January 13, 14, 1928, July 1; Pico, August 16; Terceira, October 10, 1927.

Some January specimens showed a slight enlargement of the gonads.

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[1] An addition to the avifauna of the Azores is the following:

Platalea leucorodia leucorodia Linnæus

Platalea leucorodia Linnæus, 1758, 'Syst. Nat.,' 10th Edit., I, p. 139 (Europe).

Thomson (1926, 'Problems of Bird-Migration,' p. 231) states that a banded example from Holland has been recovered in the Azores.

The wing-length of eight males is 335–354 mm ; of six females, 353–365, dimensions somewhat shorter than those recorded by Hartert ('Vog. Paläarkt. Fauna,' p. 2203). In this small island race the variation in color is much less marked than in typical *buteo*, but there are almost always dark areas on the sides of the chest, flanks, and tibiæ.

Buteo oreophilus, of the mountains of eastern Africa, bears a slight general resemblance to *rothschildi*, agreeing also in the primary formula, but it lacks the above-mentioned dark areas. Of the various buzzards breeding in tropical Africa, it is the one most likely to be regarded as a representative of *Buteo buteo*.

Cerchneis tinnunculus tinnunculus (Linnæus)

Falco Tinnunculus LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 90 (Europe: restricted type locality, Sweden).

NATIVE NAME.—Francelho.

An immature male, Terceira, December 7, 1927.

Coturnix coturnix conturbans Hartert

Coturnix coturnix conturbans HARTERT, 1917, Novit. Zool., XXIV, p. 423 (Santa Maria Island, Azores).

NATIVE NAME.—Codorniz.

Fayal, May 4, 9, 13, June 27, July 1, 2, September 5, 27, December 3, 1927, January 12, 1928; Terceira, September 28, December 7, 11, 1927.

Comparison with a series of 14 specimens of *C. c. africana* from Natal, the Kasai District, and the highlands northwest of Lake Edward, shows how closely similar *conturbans* is to *africana*. We doubt whether specimens could be distinguished unless their localities were known. It is true that in two cases the wings of our specimens of *africana* reach 110 mm., but the others fall within the range of variation for *conturbans* (99–105 mm.). In our opinion the Azorian birds are scarcely, if at all, more rufous on the upper surface of the wing.

Practically all specimens obtained between May and early September had enlarged gonads and one female taken at Fayal on September 5 contained an egg with a fully formed shell, which is preserved in the collection. Another collected on the same date had a soft egg in the oviduct. Yet on the same day Correia secured a young quail with a wing 85 mm. long, but with all the primaries enclosed in sheaths at their bases. A farmer of Fayal reported that he had found a quail's nest containing seven fresh eggs on September 26, 1925.

The egg referred to as taken from the oviduct of a dead bird is immaculate and of a pale buffy color. It measures 30×24 mm. A set of nine eggs, quite fresh, was taken from under a sitting bird at Simo da

Lomba, Fayal, on July 1, 1927. The nest was in a field of hay and was made entirely of grass. Over an olivaceous ground-color the eggs are washed with a coffee tone and are boldly splotched and spotted with rich chocolate-brown. Their range in dimensions is included within the following figures: 26×23, 28×23, 27.5×22 mm.

Crex crex (Linnæus)

Rallus Crex LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 153 (Europe: restricted type locality, Sweden).

NATIVE NAME.—Codornizão.

One female, Fayal, January 9, 1928, which was thus a wintering bird. It is doubtful whether the species breeds in the Azores.

Correia notes that the specimen was shot from a flock of quail, which recalls the classical tradition of the corn crake's leading the quail on their migrations, an idea connoted by the Greek *Ortygometra,* the German vernacular Wachtelkönig, and the Portuguese codornizão.

Gallinula chloropus correiana, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Gallinula chloropus chloropus,* but frontal shield larger at all seasons, head and throat more deeply black, coloration of lowerparts more bluish slate, especially at the sides of chest; abdomen with much less white on the tips of the feathers; claw of middle toe pronouncedly straighter than is common in European birds.

The coloration of the back and of the upper surface of the wings is about the same as in typical *chloropus,* and the wing-length is also about equal.

TYPE.—No. 222,249, Amer. Mus. Nat. Hist.; ♂ ad.; Terceira Island, Azores; December 8, 1927; José G. Correia.

MEASUREMENTS.—(3 adults of each sex): wing, ♂, 172–184, ♀, 171–175; tail, ♂, 71–80, ♀, 69–73; bill from posterior margin of frontal shield, ♂, 42–46, ♀, 38–40; maximum breadth of shield, ♂, 12–13, ♀, 11–11.8; tarsus, ♂, 47–50, ♀, 47–48; middle toe with claw, ♂, 72–74, ♀, 65–66 mm.

RANGE.—We have examined specimens only from the island of Terceira, but an Azorian moorhen has likewise been recorded from San Miguel.

NATIVE NAME.—Gallinha d'agua.

Twelve specimens, Terceira, September 26, October 11, 12, 28, December 7, 8, 1927.

Adults and immature examples are included in the series, several of the former being taken as late as December. Both males and females collected during the latter month showed distinct enlargement of the gonads. Like the resident coots, our adult moorhens, especially the December specimens, have the plumage of breeding birds, with enlarged and swollen frontal shields. While Hartert does not mention the breeding of the species in the Azores, it seems certain that it does so and that it begins its nesting period in mid-winter.

In a sense, the Azorian moorhen is analogous to the endemic quail in that it is somewhat intermediate between the European and the African forms. We have compared our series with skins of European birds in the American Museum collection and also with an excellent representation of eight specimens from Ireland, Holland and Turkestan, kindly lent to us by the Museum of Comparative Zoology. In all stages the adults of both sexes from the Azores have distinctly blacker heads and more slaty-blue breasts and flanks than any of the European examples. In this respect they resemble *brachyptera* of tropical Africa, but the back and wing-coverts are of about the same olive-brown shade as in the typical European race. The most striking distinction of the Azorian subspecies is the blackness of the belly in adults. October specimens in fresh plumage, for example, show only a slight white tipping on an area which is prevailingly slaty gray. In this respect they contrast sharply with comparable specimens from England (the restricted type locality) and from elsewhere in Europe. The difference in the character of the middle claw is a curious one, and we are not certain that it can always be relied upon. Nevertheless, every one of the specimens from Terceira has distinctly straight nails on the middle toe which contrast with the curved claws of the lateral toes. This condition is not matched among the examples from England, Ireland, or the continent, although occasionally there is a sporadic approach toward it.

Immature examples from Terceira have the feathers of the breast and flanks more bluish, if the buff or white tips of these feathers are disregarded, than European specimens of the same age. Their crowns seem likewise to be darker.

Mr. Correia's notes on the flesh colors of the Azorian moorhen are accompanied by careful water-color sketches of the head and foot. Iris, red (brown in immature birds, and also in one clearly adult female collected on September 26); bill and frontal shield, red, both mandibles tipped with yellow from about halfway toward the nostrils; bare portion of tibiæ, scarlet; heel joint and toes, dark greenish-yellow; tarsi and anterior aspect of proximal phalanges, light greenish-yellow. In immature birds, all the flesh colors are, naturally, duller.

Fulica atra atra (Linnæus)

Fulica atra LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 152 (Europe: restricted type locality, Sweden).

NATIVE NAMES.—Galeirão, mergulhão.

Terceira, September 23, October 8, 10, December 7, 1927.

The September example is a bird of the year. Adults of both sexes are recorded as showing incipient swelling of the gonads by October 10, and marked enlargement by December 7. It would seem that coots in the Azores must begin nesting in December or January, while in England they begin only in March.

In the marsh at Praia da Victoria, Terceira, the coots confined themselves characteristically to the patches of open water, while the moorhens remained among the reeds and lily pads. Correia never saw the two species close together.

Charadrius alexandrinus alexandrinus Linnæus

Charadrius alexandrinus LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 150 (Egypt).

Terceira, October 12, 28, 1927.

Though stated by Hartert to breed on the Azores, the Kentish plover was collected by Correia only at the time of the southward migration. The three specimens are in winter plumage.

Oxyechus vociferus vociferus (Linnæus)

Charadrius vociferus LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 150 (Virginia and Carolina).

One female, Fayal, January 4, 1928.

The first record of the killdeer from the Azores. Hartert mentions three occurrences in Great Britain and one at Madeira.

From the rusty margination on the upper wing-coverts, and the buffy tinge on the white ring separating the throat and breast bands, our specimen looks like a bird of the year.

Crocethia alba (Pallas)

Tringa alba PALLAS, 1764, in Vroeg, 'Cat. Adumbriaticula,' p. 7 (Holland).

Terceira, October 12, 28, 1927.

Twelve specimens in winter plumage. The sanderling is probably not an uncommon migrant, although previously known only from a single example taken at San Miguel.

Limosa limosa limosa (Linnæus)

Scolopax Limosa LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 147 (Europe: restricted type locality, Sweden).

One male, Terceira, September 23, 1927; in immature plumage, with a culmen of only 79 mm.

Scolopax rusticola rusticola Linnæus

Scolopax Rusticola LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 146 (Europe: restricted type locality, Sweden).

NATIVE NAME.—Gallinhola.

Fayal, February 21, May 10, 19, 1927.

The February birds already showed enlargement of the gonads. A female dated May 19 was incubating.

A set of four eggs taken in woods near Flamengos, Fayal, on May 10, was quite fresh. Their ground color ranges between avellaneous and wood-brown. The blotchings are of various shades of brown, from very pale to Vandyke-brown. Three of them are rather generally blotched but in the fourth the heavy pigmentation is confined to a ring around the SMALLER end. They measure: 41.5×34.5, 41×35, 40×34, 41×33 mm.

Larus fuscus atlantis Dwight

Larus fuscus atlantis DWIGHT, 1922, Amer. Mus. Novit., No. 44, p. 1 (Fayal, Azores).

NATIVE NAMES.—Gaivota, ganhoa.

Fayal, May 4, 11, 1927, January 4, 14, 1928.

An excellent series of birds in various stages of plumage. The spring adults were breeding birds, and a female collected on May 11 contained an egg ready to lay.

The iris in adults was yellow, the feet and legs, yellow. In young birds the iris was brown, the feet and legs, "cream."

We follow Dwight (1925, Bull. Amer. Mus. Nat. Hist., LII, pp. 215, 216, Fig. 139) in regarding the Azorian gull as a race of *fuscus*.

Hydrocolœus ridibundus ridibundus (Linnæus)

Larus ridibundus LINNÆUS, 1766, 'Syst. Nat.,' 12th Edit., I, p. 225 (Europe).

Fayal, January 7, 24, 1928.

Adults in winter plumage and young of the year.

This gull in winter plumage is locally known by the Portuguese equivalent of "four-eyes," because of the dark spot behind the eye. The specimens were collected on farm-land two thousand feet above sea-level. The birds were observed also about the lake at Furnas, San Miguel.

The species is a regular migrant to the Azores, and Thomson (1926, 'Problems of Bird-Migration,' p. 231) has recorded the recovery of an example banded in Yorkshire.

Sterna hirundo hirundo Linnæus

Sterna hirundo LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 137 (Europe: restricted type locality, Sweden).

Pico, July 9, Aug. 19, 1927.

All with enlarged gonads. A female collected on August 19 was mating at that late date.

Twenty sets of eggs, mostly slightly incubated, were taken from a large colony of common terns at Pico on July 9. The eggs lay on bare lava rock, and no set comprised more than two. In twelve cases out of the twenty there was but one. This would seem to be notable, for the same species in eastern North America usually lays three of four, often five, eggs, while in northern Europe three is commoner than two. Possibly both the small sets and the late date of the Azorian specimens are explicable on the grounds that the parent terns had bred before during the season.

The variation in size, form, and pattern of the eggs presents no unusual features. Characteristic measurements from a series of 28 are as follows: 46×32.5, 39×30, 41×29.8, 44.3×31.2, 45.3×31, 40×31, 42×31.5, 43×32 mm. Extreme dimensions among 18 common tern eggs from New York, Rhode Island and Massachusetts are: 43.5×31, 38×29.5, 40×29 mm.

Sterna dougallii dougallii Montagu

Sterna Dougallii MONTAGU, 1813, 'Orn. Dict. Suppl.,' no page (Firth of Clyde, Scotland).

A female, not in breeding state, Pico, July 9, 1927.

The first definite record of the species from the Azores. Hartert and Ogilvie-Grant (p. 101) report: "*Sterna dougalli* is said to have occurred by Godman and Simroth."

Columba livia Gmelin

Columba domestica β livia GMELIN, 1789, 'Syst. Nat.,' I, p. 769 (no type locality; later restricted to southern Europe).

NATIVE NAME.—Pomba da rocha.

Pico, July 8, 12, 13, 21, 27; Terceira, October 11, 1927.

The July specimens were in breeding condition; those taken in October had small gonads.

It is quite evident that all these pigeons are the descendants of domestic birds. All but one are very dark-colored, if not blackish, above, and flecked with gray on the wing-coverts. Yet more than half of them have white rumps. Only a single specimen approaches the wild coloration, but it is dark on the head and its rump is bluish gray.

At Pico in July the rock doves spent much time about human dwellings, perching on roofs and stone walls and waiting for the inhabitants to feed the poultry. At such times they would fill their crops quickly and then fly off to their crevices among the sea cliffs.

The contents of four full crops of rock doves, collected by Mr. Correia at Pico, have been analyzed by Mr. E. R. Kalmbach, of the United States Bureau of Biological Survey, as follows:

1.—Percentage of animal matter, 0; of vegetable, 100; of gravel, etc., trace. Contents: 48 seeds of *Chætochloa glauca* + 2 *Bromus* sp., 1 per cent; 80 seeds of *Sherardia arvensis* + several of *Salium* sp. + 20 *Ornithopus*, probably *rosea* + 1 *Euphorbia*, 1 per cent; 4 *Glycine* sp. + 2 seeds of another legume + 43 seeds of *Vicia* sp., 10 per cent; fragments of foliage, 2 per cent; 49 tubers of a sedge (*Cyperus*), 15 per cent; at least 50 tubers of *Stachys* sp. (?), 71 per cent; 1 kernel of rye + hulls of corn (*Zea mays*), trace.

2.—Percentage of animal matter, trace; of vegetable, 100; of gravel, etc., 1. Contents: 1 *Polygyra* sp., trace; shell of hen's egg, trace; 123 seeds of *Glycine*, 68 per cent; 30 of *Ornithopus* sp., probably *rosea*, 2 per cent; hulls of corn (*Zea mays*), trace; 25 tubers of a sedge (*Cyperus* sp.), 10 per cent; 16 tubers of *Stachys* sp. (?), 20 per cent.

3.—Percentage of animal matter, trace; of vegetable, 100; of gravel, etc., 1. Contents: 1 *Polygyra* sp., trace; 32 seeds of *Spergula* sp., 1 per cent; 3 seeds of *Glycine* sp., 1 per cent; 380 tubers of a sedge (*Cyperus*), 93 per cent; 6 tubers of *Stachys* sp.?, 5 per cent; hulls of corn (*Zea mays*), trace; foliage, trace.

4.—Percentage of animal matter, trace; of vegetable, 100; of gravel, etc., 1. Contents: head and thorax of 1 *Calendra zea-mais*, trace; 23 larvæ + 1 puparium of *Sarcophaga* sp., trace; 2 *Polygyra* sp., trace; fragments of shell of hen's egg, trace; 6 tubers of *Cyperus* sp. + 3 other tubers, 3 per cent; 82 soy beans (*Glycine*) + 2 other *Glycine* + 20 *Vicia* sp. + 78 *Ornithopus*, probably *rosea*, 25 per cent; 1 *Euphorbia* sp. + 6 *Sherardia arvensis* + 31 *Spergula* sp. + 4 *Bromus* sp., 1 per cent; 68 kernels of yellow dent corn, 66 per cent; 115 kernels of rye, 4 per cent; fragments of "excelsior," 1 per cent.

NOTE.—The *Sarcophaga* larvæ are present possibly through the exposure of the stomach contents before preservation.

Columba palumbus azorica Hartert

Columba palumbus azorica HARTERT, 1905, Novit. Zoöl., XII, p. 93 (Terceira Island, Azores).

NATIVE NAME.—Pomba torcáz (or trocáz).

Fayal, April 28, May 9; Pico, July 16, 21, 22, 27, 28, 1927.

All in breeding condition. A female taken May 9 contained an egg ready to be laid. On July 22, when most of the young pigeons were already flying, Correia took a fully formed egg from a bird shot at Pico. It measures 40×27.6 mm.

We find, as Hartert has stated, that the Azorian birds are a little more richly colored than specimens of typical *palumbus* from western Europe. Their wings are slightly shorter, measuring in the present series, 230–246 (six males), 252 (two females). It is surprising that the females are both so large.

The wood pigeon was the only species observed eating ripe grapes from the vines. The crop contents of a Pico specimen has been analyzed by Mr. Kalmbach as follows:

> Percentage of animal matter, trace; of vegetable, 100; of gravel, etc. 2. Contents: 1 *Calendra zea-mais*, trace; snail (Zonitidæ), trace; 1 seed of *Ornithopus*, probably *rosea* + 1 *Sherardia arvensis*, trace; 1 *Glycine* sp., trace; hulls of corn, trace; bits of foliage (*Amaranthus* sp.?), trace; at least 60 tubers of *Stachys* sp. (?), 100 per cent.
>
> NOTE.—About 70 larval + 2 pupal sarcophagids present are apparently the result of the stomach material being exposed after collection—not classed as food.

Nyctea nyctea (Linnæus)

Strix Nyctea LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 93 (Sweden).

A female, Fayal, January 14, 1928.

This is the first record of the snowy owl from the Azores.

The specimen has greatly frayed primary quills and it is not impossible that it may have been carried in captivity on board some ship from the western side of the Atlantic. From the appearance of the wings one might conclude that it had retained little power of flight, but such is far from the case, as shown by Mr. Correia's notes.

The owl was first reported to him by a farmer of Fayal who sent him word that a large white bird of an unknown kind had flown past him rapidly and had alighted in the middle of a clear field. This was on the morning of January 12, but when Correia reached the spot the bird had gone. While discussing the matter with the farmer, however, it came by again at a distance of about five hundred feet, dropped over the sea cliffs and disappeared. Several hours later in the same day Correia saw the owl again, but only at a long distance. Next morning, January 13, another farmer said that a large white bird had come in from the sea and had rested on a stone wall about forty feet from where he was working, remaining quietly for an hour. Correia located the bird near this spot but was unable to get within range. On the afternoon of the following day, January 14, he and a friend stalked the owl for several hours and finally collected it while it sat on the ground in open country.

Asio otus otus (Linnæus)

Strix Otus LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 92 (Europe: restricted type locality, Sweden).

NATIVE NAMES.—Môcho, coruja.

Terceira, October 7, 10, 13, 1927; Fayal, March 22, 1928.

The March bird was a male with enlarged testes. The long-eared owls of the Azores, though resident there, are not separable from the typical race. There is a slight variation in color, but while our most richly-hued specimen can be matched with the darker European and Asiatic examples, none of our four Azorian birds is as pale as the lighter-colored continental birds. Three males have wings measuring 274, 288, 292 mm.; one female, 286.

Alauda arvensis cantarella Bonaparte

Alauda cantarella BONAPARTE, 1832–1841, 'Iconogr. Fauna Ital., Uccelli,' Introd., p. 5 (Italy).

Alauda arvensis cantarella, MURPHY, 1923, Ibis, p. 48.

One female, Fayal, Jan. 14, 1928.

This specimen and a female taken by Correia at the same island on Jan. 5, 1922, have been compared with the series of European skylarks in the British Museum and in the Zoölogical Museum at Tring. They agree with females of the race *cantarella* from Spain, Cyprus, and other Mediterranean localities. The same subspecies was recorded as a migrant in the Azores by Hartert and Ogilvie-Grant.

Motacilla cinerea schmitzi Tschusi

Motacilla boarula schmitzi TSCHUSI, 1900, Orn. Jahrb., XI, p. 223 (Madeira).

NATIVE NAMES.—Labandeira, arvelhina.

Fayal, May 2, 4, June 30, July 1; Pico, July 9, 12, 13, 29, August 18; Terceira, October 11; San Miguel, November 11, 1927.

This series exhibits the subspecific characters given by Dr. Hartert ('Vögel Pal. Fauna,' p. 301), and we find that five adult females taken between May and August have the throats blackish, mixed with gray. The wing-length in four adult males is 83–86 mm.; six adult females, 77–80.

The breeding season of the wagtail evidently extends into July. November birds from San Miguel are in fresh plumage, with white throats.

Regulus regulus azoricus Seebohm

Regulus cristatus var. *azoricus* SEEBOHM, 1883, 'Hist. Brit. Birds,' I, p. 454 (Azores: type locality here restricted to San Miguel).

NATIVE NAME.—Cespina.

San Miguel, Nov. 10, 11, 15, 16, 1927.

Seebohm's description, which distinguishes no particular island, is as follows:

> On the Azores a form is found having the olive-green nape of *R. cristatus*, but with a much larger bill, the culmen measuring .5 inch instead of .45 to .4. I propose to call this form *Regulus cristatus* var. *azoricus*.

This might apply to specimens from any island of the group, but we find that in all probability the only Azorian skins available to Seebohm at the time of his study were three in the Salvin and Godman collection, taken during March and April, 1865, and deposited in the British Museum in 1879. Two of these are from San Miguel, the other from Fayal.

Now since the goldcrest of San Miguel proves to be subspecifically distinct from that of Fayal and the other islands of the Azores, we hereby arbitrarily restrict the type locality of Seebohm's race to San Miguel, and designate as the type specimen Brit. Mus. Reg. 1879, 4. 5. 307, ♀, April, 1865, F. Godman.

Our seven San Miguel skins are all heavily washed with olive-buff on the ventral surface, and in this respect are strikingly different from goldcrests collected by Correia at Fayal and Pico during Jaunary, February, April, May, July, August, November, and December (years 1921, 1922, 1927). Moreover, twenty additional San Miguel specimens examined by the senior author in the British Museum, and dated during the months of March, April, and May, can likewise be picked out from the remainder of the large Azorian series by the color of their ventral surfaces, without the necessity of consulting the labels. Dr. Hartert's suggestion that such plumage differences may be seasonal would seem, therefore, to be invalidated.

The size of the bill in both Azorian races is quite appreciably larger than in European specimens. Measurements of ten males and females of *azoricus*, from San Miguel, fall within the following ranges: wing, 51–55; tail, 35–38; bill from proximal end of nostril, 8.5–9.5 mm. The last measurement is more easily determined with exactitude than the length of the culmen.

Regulus regulus inermis, new subspecies

SUBSPECIFIC CHARACTERS.—Similar to *Regulus regulus azoricus*, but distinctly less olive-buffy on the entire ventral surface, and with soiled whitish areas on throat, belly and flanks, which are rarely if ever apparent in examples of the San Miguel race.

TYPE.—No. 222,332, Amer. Mus. Nat. Hist.; ♂ ad.; Pico Island, Azores; July 22, 1927; José G. Correia.

MEASUREMENTS.—(16 males and females from the six islands listed below): wing, 51–55; tail, 36–39; bill from proximal end of nostril, 8.2–9.5 mm.

RANGE.—Islands of Santa Maria, Terceira, Pico, Fayal, San Jorge, and Flores, Azores Group.

NATIVE NAMES.—Ferfolha, estrellinha.

Fayal, April 28, May 10; Pico, July 14, August 13, 1927.

We have compared the recently collected specimens with others obtained by Correia during 1921–22, as well as with the excellent series in the British Museum, to a total number of 46 examples of this race from the six islands named above.

This subspecies appears not to differ in size from the endemic form of San Miguel, but all examples are sufficiently lighter and grayer on the ventral surface so that adults may be distinguished at a glance from those of San Miguel, and without regard to condition of plumage or time of year.

Birds from the different islands, even from such widely separated breeding stations as Santa Maria and Flores, are remarkably uniform. Indeed, only specimens from Fayal, the nearest island to the type locality, have a very slightly darker ventral aspect than the average range among those collected at the other localities. In this respect, Fayal birds show a bare suggestion of being intermediate, though the approach is too vague to be definitely described, and the affinities of the resident birds are clearly with *inermis* rather than with *azoricus*.

The phenomena presented by the two races of goldcrests in the Azores—one generally distributed, the other exclusive at a single island—is a familiar one in insular zoölogy. It is particularly well known to entomologists. In ornithology, a parallel case is that of the warblers (*Conopoderas*) inhabiting the Tuamotu atolls of the South Pacific. Twenty-eight far-flung islands of this group, for example, are occupied by a single subspecies, whereas two apparently undifferentiated islands have slightly distinct endemic races (cf. Murphy and Mathews, 1929, Amer. Mus. Novit., No. 350, pp. 3–14). San Miguel is the largest body of land in the Azores, and it may have environmental peculiarities. Probably, however, the essential problem is bound up chiefly with the segregation of a mutant strain.

Ferfolha, the commonest name of the goldcrest in the Azores, means "busybody."

Sylvia atricapilla atricapilla (Linnæus)

Motacilla Atricapilla LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 187 (Europe: restricted type locality, Sweden).

NATIVE NAME.—Toutinegra.

Fayal, April 26, May 3, September 8, 1927, January 12, 1928; Pico, July 22, 28; Terceira, September 27, October 13, December 12; San Miguel, November 15, 1927.

Fledglings were taken at Fayal on September 8.

On September 26, Correia observed at Terceira a blackcap in the phase which has been described as *S. a. heineken.* This plumage is seen often enough at the island to be popularly known, and to bear the vernacular name "Touto vinagreiro."

A nest with four fresh eggs, four feet from the ground in a small "incense tree" by the roadside, was taken at Flamengos, Fayal, on May 13. It is built of trailers of green fern-moss, lined with fine rootlets. The eggs are pale buffy, with evenly distributed blotchings of a brownish tone, and a few dark spots where the brown pigment is concentrated. They measure from 20×14.4 to 20×14.8 mm.

Erithacus rubecula rubecula Linnæus

Motacilla Rubecula LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 188 (Europe: restricted type locality, Sweden).

NATIVE NAMES.—Paipalo, Santo Antonino (San Miguel).

Fayal, May 11, June 27, 30; Pico, July 2, 10, 13, 15, 27, Aug. 18; Terceira, September 27, 28, October 13, December 6; San Miguel, November 15, 17, 18, 1927.

The breeding season of the robin is evidently under way by early May. Fledglings were moving about by July 2.

November adults from San Miguel are in entirely renewed plumage, with slightly darker and richer red breasts than spring birds.

At Fayal, Correia found a robin's nest containing one egg, on a Monday afternoon. By Friday noon there were five, the full set.

The collection includes two nests, with sets of eggs. The first taken at Flamengos, Fayal, May 13, was in a hollow of a roadside embankment. The other, from Santo Antonio on the same island, May 14, was in the chink of a stone wall, two feet above a main and much-traveled highway. Both are made of rootlets, finest in the lining, with a few heavy grass or herb stalks in the outer structure. Their bowls are about 8 cm. in diameter. The eggs, five in one nest, six in the other, were fresh. They are white, with closely clustered specklings of army brown, which tend to be concentrated at the larger end, but which are more generally distributed on one egg in each nest. The dimensions are all included within the following figures: 19×14.3, 19.5×14.5, 20×15 mm.

Turdus merula azorensis Hartert

Turdus merula azorensis Hartert, 1905, Novit. Zoöl., XII, p. 116 (Graciosa, Azores).

Native Name.—Melro preto.

Fayal, May 2, 3, 4, 6, 7, 9, 11, June 27, July 2, September 5; Pico, July 9, 10, 12, 15, 21, 22, 23, 25, 28, August 12; Terceira, September 28, October 10, 11, December 12; San Miguel, November 11, 14, 1927.

The Azorian blackbird is darker than the typical European race, blacker and glossier in the male, more blackish brown in the female. In coloration it is like *cabreræ* of Madeira and the western Canaries, with which it agrees in having rather short wings. But the tail in *azorensis* is a trifle shorter than that of *cabreræ*. Wing-length of twenty males of *azorensis*, 120–130 mm.; of sixteen females, 118–125 mm. Tails of twenty males, 93–102 mm.; of sixteen females, 83–95.

The differences between the three races mentioned above are, therefore, slight, and there is some overlapping in measurements. The bills of the island races may be slightly thicker, but the difference is not marked.

The blackbirds evidently have a prolonged breeding season. Eggs began to appear as early as May 2, and yet some females had the ovaries much enlarged toward the end of July. Fledgling young were collected as early as June 27 and as late as September 5.

Many September and October specimens, both adults and young, are moulting, while November birds are in handsome new plumage.

On one May day at Fayal, Correia found numerous unfinished nests, one containing three naked young, and another with four fledglings within a few days of their first flight. Sometimes two eggs constitute the full set. At Terceira he watched the building of a nest in a fig tree, six feet above the ground and close to a house. In this and other instances the female worked much more industriously than the male, making three or four trips for material while the male made one. The females were also more determined in defending the nests, pursuing an intruder with loud cries.

At Fayal during the middle of June, families of young blackbirds were following their mothers. When two youngsters were confined in a cage, the old female continued to feed them for many days, even waiting about a house in the morning for the cage to be hung out of doors. A stray youngster from another family was added to this group and all three were fed indiscriminately until they had attained full growth and were released.

Correia reports that both the bill and the legs of the blackbird turn dark during the post-nuptial moult.

The collection includes three nests with eggs. The nests are bulky affairs of grass, roots, vines and herb stalks, and, in one case, green moss. No mud enters into the construction. The linings are of fine wisps of grass and the skeletal structure of macerated leaves. Their bowls are approximately 10 cm. in diameter and of more than half that depth. The outside diameter of the thick-walled baskets measures up to 20 cm.

One, taken at Horta, Fayal, May 7, was built ten feet high in a Japan rose shrub, and contained four fresh eggs. Another, from Flamengos, Fayal, contained two eggs on May 13. This was in an "incense tree" in dense forest, built eight feet above the ground. The altitude of the region is 2000 feet above sea-level. The third nest, from Terceira, was six feet up in a fig tree overhanging a road, and contained three eggs on June 12.

The eggs in the three sets are of uniform appearance, with reddish flecks and fine blotches distributed rather evenly over a background of very pale blue or greenish blue. Their dimensions are included within the following figures: 29×21, 30.5×22, 29.5×22, 31.3×22.6 mm.

Sturnus vulgaris granti Hartert

Sturnus vulgaris granti HARTERT, 1903, 'Vög. Pal. Fauna.,' I, p. 43 (Graciosa, Azores).

NATIVE NAME.—Estorninho.

Fayal, April 26, May 4, 6, 11, June 27, 28, July 2, 28, September 5, 6; Pico, July 26, 29, 30, August 11, 13, 16; Terceira, September 26, October 28; San Miguel, November 15, 1927.

We can scarcely confirm the differences given by Dr. Hartert to distinguish this race from typical *vulgaris*. The wings of 12 males measure 128–133 (130), of 7 females, 125–129 (127). Those of European birds: 5 males, 126–130 (128); 4 females, 126–129 (127.5). The bills of Azorian specimens do not seem narrower, and in 18 specimens of both sexes the extremes in length are 23 to 25 mm., or exactly as in 9 European specimens of both sexes.

The outermost primary of Azorian birds varies from 7.8 to 12.5 mm., that of European specimens from 10.5 to 13. mm. This seems to be the best-marked difference between the races.

The starlings breed early and flocks of young birds, mostly by themselves, begin to move about by the middle of June.

During the latter part of July the moult of the adults commences, and early in August the young birds begin to replace their gray juvenal feathers with the first winter plumage. By the end of September this transformation had been mostly completed for both the adults and young.

While the starlings were undergoing the rapid moult into winter plumage, Correia reports that their yellow beaks turned dark. At Pico, during late July, these birds were busy searching for figs.

Fringilla cœlebs moreletti Pucheran

Fringilla Moreletti Pucheran, 1859, Rev. et Mag. de Zool., pp. 409–412, Pl. xvi (Azores).

Native Name.—Tentilhão.

Fayal, April 23, 26, May 2, 4, 7, 9, 13, June 27, September 5, 7, 8; Pico, July 12, 15, 21, 30, August 12, 19; San Miguel, November 10, 11, 15, 17, 1927.

Specimens with enlarged gonads were taken from early May until mid-July; fledglings between June 27 and September 7. The postnuptial moult is in active process during September, and November specimens are in brilliantly fresh plumage.

We have compared these birds with examples of *Fringilla cœlebs maderenis*, collected at Madeira by Mr. Jesse Metcalf, and find the subtle but clear differences noted by Hartert, particularly those showing in the pattern of the outer rectrices.

The collection includes a set of three eggs, which were slightly incubated, taken at Flamengos, Fayal, May 14. The nest, which was apparently not preserved, was in a small tree and was made of dry grass, lined with hair and feathers. The eggs are pale bluish, with indistinct vinaceous blotches and with small spots and vermiform marks of a maroon hue. They measure 21×16, 21×15.7, 21×15.7 mm.

Pyrrhula pyrrhula murina Godman

Pyrrhula murina Godman, 1866, Ibis, p. 97, Pl. iii (San Miguel, Azores).

Native Name.—Priôlo.

San Miguel, November 11, 15, 18, 1927.

The Azorian bullfinch may be regarded as a "hen-feathered" race, the male being without any reddish coloration, thus resembling the female of the typical form, except that it is more brownish, and has a light gray instead of a white rump-spot. The wings of our four males measure 88–89.5 mm.; of one female, 86.

While the two races of bullfinch that inhabit Europe show marked sexual difference in color, the reddish wash on the breast is very variable, often wanting, in males of the Japanese representative, *griseiventris*. The throat and cheeks in this form, however, always retain their rosy color in the male. A closer parallelism to *murina* is exhibited by *cassini* of Central Asia, in which the male is wholly without red or pink, but the rump-spot remains white. Farther east, in Kamtchatka, lives still another race with red-breasted males like those of Europe.

If, as in domestic fowls, the bright colors of males can be inhibited by internal secretions, which in some races are produced only in females, there would seem to be a tendency among certain races of bullfinches for such a secretion to occur also in males. Hen-feathering of this sort is known to be hereditary, and the Azores would furnish the necessary isolation for the development of a peculiar race. On the other hand, the European bullfinch is a bird among which at least three gynandromorphs have been found, with male coloration on one side of the body (usually the right) and female garb on the other. This would seem to indicate that the colors are determined by the chromosomal content of the cells of the skin, and not influenced by a hormone.[1]

When Correia landed at Ponta Delgada, San Miguel, in early November, he was assured that there was no chance of collecting bullfinches. The birds have been persistently shot because of their blossom-eating propensities in the orchards, and none had been reported for two years or more. While still supposed to exist, the bullfinches were said to be restricted to the dense forest of the uplands except during part of the spring season.

However, on November 8 he went to Furnas, twenty-seven miles distant from the port. The region lies in a valley surrounded by steep hills, with a small lake and mineral springs of various flavors and temperatures. The commonest birds proved to be the blackbird, chaffinch, starling, robin, wagtail, blackcap, and kinglet, with a few wood pigeons in the taller growth of the slopes.

On the morning of November 10 the weather was clear, after rain during the whole night. Correia asked some of the inhabitants as to where he might find the priôlos, but their answers proved unsatisfactory. He was told that the birds were formerly seen in spring, but that during the winter they retired to the higher forests and were difficult to locate. He was at the point of losing hope when one man asked him what reward would be paid for each priôlo that he might discover for the collector. One dollar per bird was offered but the man demanded two, so Correia went off to try his luck alone. He wandered over the hills and through the woods, into orchards and gardens, seeing many birds, but not those sought, so he returned and hunted up the resident who had agreed to find the prize.

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[1] The condition of reproductive organs in such gynandromorphs has been described by R Neunzig, 1924, Gefiederte Welt, LIII, pp 93, 246, 247, and J W Harms, 1926, 'Korper und Keimzellen,' pp 431-433, Figs 185, 186. Castration and the introduction of an ovary failed to alter the plumage of normal red-breasted males See V. A Hachlow, 1927, Archiv f Entwicklungsmechanik, CX, pp 279-301.

On November 11 he and his guide repaired to the forest along the lake known as Lagoa das Furnas. This is about 400 feet above the level of the valley; there is no flat land about it but only steep hillsides covered with large trees. At a point on the edge of the lake, where a charming little stone chapel stands, the guide began to call for priôlos by making short whistles every two seconds. Suddenly he announced the approach of a bird, which came presently within Correia's ken and answered each call. The victim hopped from tree to tree to within ten feet. Two more hours of patient calling was finally answered by another bird from a distance, and within four minutes this one also approached within collecting range.

The above episode took place partly during heavy showers of rain. Next day, November 12, Correia went to the same region and whistled for himself through equally heavy downpours, but without attracting any of the bullfinches into ambush.

On November 13 and 14 it rained hard all day. On the 15th he once more took his guide, who immediately called up a bullfinch at the usual place. The guide then said that as the priôlos usually travel in pairs he would have another within five minutes, which turned out according to prophecy. The final specimen was decoyed in the same manner on November 16. Four of the five are males.

Many of the people of Furnas stated that they had not seen a priôlo for ten years, and some of the younger folk, who knew the bird by reputation, asked to examine Correia's specimens.

Serinus canaria canaria (Linnæus)

Fringilla canaria LINNÆUS, 1758, 'Syst. Nat.,' 10th Edit., I, p. 181 (Canary Islands).

NATIVE NAME.—Canario.

Fayal, April 26, May 4, 6, 7, 9, June 27, July 1; Pico, July 8, 14, 15, 16, 21, 22, 30, August 18, 19; Terceira, September 28, October 11, 12, December 6; San Miguel, November 21, 1927.

Fledglings were taken by July 1. November adults from San Miguel are in recently renewed plumage.

A nest taken at Pico on August 19, site not recorded, is woven of grass and rootlets, with a heavy lining of what appears to be thistledown. The bowl is about 6 cm. in diameter.

Carduelis carduelis parva Tschusi

Carduelis carduelis parva TSCHUSI, 1901, Orn. Monatsber., p. 129 (Madeira).
NATIVE NAME.—Pintasilgo.

Terceira, October 11, 24, 28, December 3, 7, 8, 1927.

Noted in large flocks of migrants at Terceira during the latter part of October. They belong, however, to the resident race, which is smaller and darker, duller brown on the back, than either the British or the continental European races. Wings of four males in the present collection measure 72–76 mm.; of four females, likewise, 72–76. It is supposed that the goldfinch was introduced into the Azores from Madeira, the same race being found there and in the western Canaries.

AMERICAN MUSEUM NOVITATES

Number 385 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Nov. 8, 1929

55.1 (51.7)

ADDITIONAL NEW FORMATIONS IN THE LATER SEDIMENTS OF MONGOLIA[1]

BY CHARLES P. BERKEY, WALTER GRANGER, AND FREDERICK K. MORRIS

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INTRODUCTION

During 1925 the Central Asiatic Expedition examined new ground, restudied several districts, and gathered abundant new fossils. It is allowable now to define several additional new formations as another step in the interpretation of the stratigraphy of the Gobi region and as a support to palæontological research.

The so-called "later sediments" of the Gobi region include the nearly horizontal strata which lie above a great unconformity, and so are readily distinguished from the deformed and much modified structures of the peneplaned ' oldrock floor '"[1] For the purposes of the present paper, it matters little whether the oldest of the later sediments be regarded as Upper Jurassic[2] or Lower Cretaceous [3] This question will be more fully discussed in another report, now in preparation

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 95.

All places mentioned in this paper are shown on the map, Fig 1

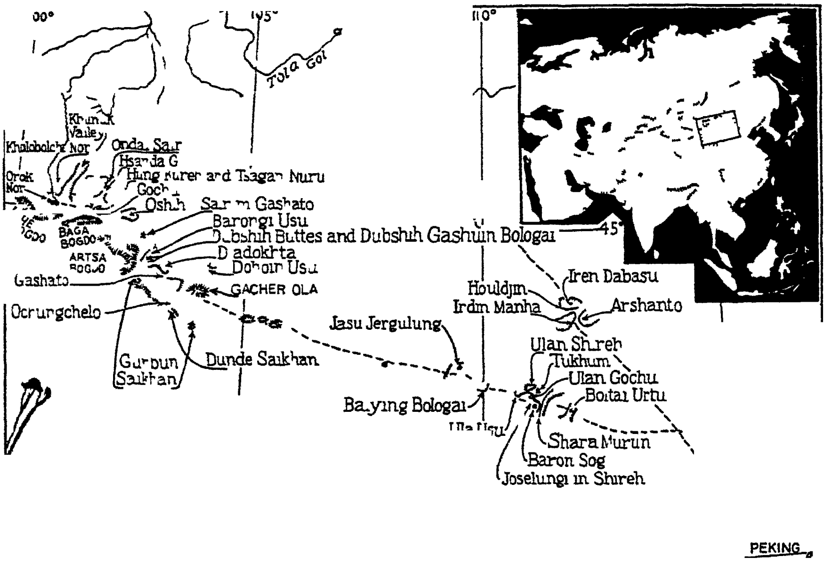

Fig 1 Map showing the location of places referred to in this paper (Based chiefly on the survey by L B Roberts in 1925)

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[1] Granger Walter and Berkey Charles P 1922 Discovery of Cretaceous and Older Tertiary Strata in Mongolia Amer Mus Novitates No 42 Berkey Charles P and Granger Walter 1923 Later Sediments of the Desert Basins of Central Mongolia Amer Mus Novitates No 77 Berkey Charles P and Morris Frederick K 1924 Basin Structures in Mongolia Bull Amer Mus Nat Hist Vol LI Art V pp 103-127 Berkey Charles P and Morris Frederick K 1927 Geology of Mongolia Nat Hist of Central Asia Vol II

[2] Osborn Henry Fairfield 1926 Article Paleontology in Encyclopædia Britannica

[3] Berkey Charles P and Morris Frederick K 1924 Basin Structures in Mongolia Bull Amer Mus Nat History Vol LI Art V pp 109-115 Berkey Charles P and Morris Frederick K 1927 Geology of Mongolia p 354

TABLE OF NEW FORMATIONS

Period	Formation	Thickness	Sediments
		(in feet)	
Pleistocene	Orok Nor	10	Coarse gravels
	Tsagan Nuru	40	White sands
	Khunuk	130	Buff sands and clays
	Joselungi	12	Brown gravel and sands
Oligocene	Baron Sog	30	White and gray sands and clays
	Ulan Gochu	60	Red clays
	Jirilgo (probably equivalent to Hsanda Gol)	40	Red, brown, and gray clays
Eocene	Ulan Shireh (possibly Shara Murun)	300	Red and gray clays and sands
	Elegen	70	Gray sands and clays
	Kholobolchi	500	White and yellow sands and clays
Lower Cretaceous	Dohoin Usu	300	Red clays, sands
	Dubshih	1000	Conglomerates, sands
	Ochungchelo	2000	Clays, sands, conglomerates
	Baiying Bologai	150	Red clays and sands
	Jasu Jergulung (possibly equivalent to Ondai Sair)	100	Black paper shales

LATE MESOZOIC FORMATIONS

At five different localities sediments were found of enough prominence and unity of character to warrant giving them formational designation. It is entirely possible that some of them are simple equivalents of formations already described and more fully defined. But it is more likely that they cannot be matched, and, for present purposes, it is serviceable to treat them as definite formations, recognizing their local rather than their regional significance. Additional studies of the respective faunas will doubtless clear some of the uncertainties of correlation. The list is described, beginning at the base.

JASU JERGULUNG.—About eight miles west of the frontier customs station, Jasu Jergulung, about Lat. 42° 55′ N., Long. 109° 40′ E., there is an eastward-facing escarpment of typical paper-shales, with abundant *Estheria middendorffi.* The beds may be called the Jasu Jergulung formation, as no native name could be found for the scarp itself, and they may be correlated with the Ondai Sair.[1] The exposed thickness is about 100 feet. The base was not seen; the top is the Gobi erosion plane.

BAIYING BOLOGAI.—At Baiying Bologai, about 27 miles east of the Yamen Jasu Jergulung, there is a basin of red clays and sands, with indurated sandstone members, in which sauropod bones were found. Physically the beds resemble the Oshih sediments. The base of the Baiying Bologai formation rests unconformably upon the beveled edges of tilted sandstones and conglomerates, belonging to the oldrock floor. Rounded pebbles of Permian limestone were found in the conglomerates, hence they are post-Palæozoic. They were deformed and eroded before the deposition of the Baiying Bologai. Tentatively, the conglomerate-sandstone series has been assigned to the Jurassic. The Baiying Bologai formation is beveled by the Gobi erosion plane, and hence its upper limit is unknown. Its thickness is at least 150 feet, and may be considerably more.

OCHUNGCHELO.—Along the northern foot of the Gurbun Saikhan mountains there are upturned conglomerates, sandstones, sands and clays, with a few thin beds of inland-water limestone. Near Ochungchelo, at the front of the Dunde Saikhan range, a single sauropod bone was found, indicating either the Lower Cretaceous or the Upper Jurassic age of the sediments. Beginning with conglomerates, the section passes into redbeds, chiefly clays, about 1,000 feet thick. They are succeeded by gray beds, more than 1,000 feet thick, consisting chiefly of clays, with thin sandy layers and minor limestone lenses. Many of the beds are limy and hard; some are shattered, and the fractures are healed with carbonate veins. The strata are tilted along the mountain front, dipping as much as 48°. Dips of 40° continue for over 2,000 feet out from the mountain face, and minor faults traverse the formation.

The prevailing fineness of grain, and the regular and thin bedding, render it quite impossible for the Gurbun Saikhan ranges to have been prominent when these beds were laid down. It is more probable that much, if not all, of the site of the present mountains was covered by the deposits of later Mesozoic time, a suggestion that is strengthened by the great thickness of the upturned beds. In other reports[2] we have postulated a sedimentary cover of the Gurbun Saikhan during Lower Cretaceous time, basing the inference chiefly upon studies of the Djadokhta and Gashato beds.

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[1] Cockerell, T. D. A. 1924. 'Fossils in the Ondai Sair Formation, Mongolia.' Bull. Amer. Mus. Nat. Hist., Vol. LI, Art. VI, pp. 129–144. Berkey, C. P., and Morris, F. K. 1927. Geology of Mongolia, pp. 230, 354.

[2] Berkey, C. P., and Morris, F. K. 1924. 'Basin Structures in Mongolia' Bull. Amer. Mus. Nat. Hist., Vol. LI, Art. V, p. 118. Berkey, C. P., and Morris, F. K. 1927. Geology of Mongolia, pp. 316–317.

The base of the Ochungchelo rests directly upon the complex oldrocks of the Gurbun Saikhan. The edges of the tilted strata are smoothly beveled by the Gobi erosion plane. The northward dip, if the formation continues far out into the basin, would carry it underneath the Djadokhta and Gashato formations. It may, therefore, be essentially equivalent to the Dubshih formation next to be mentioned, which certainly lies immediately beneath the Djadokhta formation at the westerly border of the district.

DUBSHIH.—About 14 miles west of our camp at Shabarakh Usu in the Djadokhta district, there is a broad dry valley called Baron Ghi Usu, tributary to the still larger Shabarakh valley. On the east side of the channel a mesa of rhyolite and basalt, called Dubshih, forms the most prominent landmark for many miles. The name, Dubshih Gashuin Bologai, is given to an important spring on the main caravan trail, three miles east of the mesa. In the dissected ground between Dubshih mesa and the spring, Dubshih Gashuin Bologai, there is a series of tilted strata which forms a stratigraphic unit, and which has been designated as the Dubshih formation.

The beds dip eastward at angles varying up to 20°. The steepest dips are found in the western, or lower, beds, near the mesa, but in the mesa itself the lava flows lie horizontally. The higher beds dip at progressively smaller angles until they become sensibly horizontal. It is estimated that the thickness cannot be less than 1,000 feet, and it is probably more, since the base of the formation is not exposed and the nearest exposure of the oldrock floor is fifteen miles to the northwest.

The sediments here include two members: a lower group of pebble conglomerates, sandstones, and thin white limestones, all together totaling at least 530 feet; and an upper group, made up chiefly of coarse rubble, rhyolitic tuff and ash but including also conglomerates with pebbles derived from older sediments and porphyries. This member is nearly 300 feet thick.

In the lower conglomerates the pebbles are chiefly of fine-grained phyllite, with fairly abundant limestone pebbles, some of which bear Palæozoic fossils. Less abundant are quartz, jasper, graywacke, and silicified ash, or argillite. The limestones consist of a fine-grained white lime mud, like marl, which includes varying amounts of sand. Dense white marly masses like concretions are present in some layers. The white lime beds contain shells of a small pelecypod and a gastropod.

Our collection has been sent to Professor Grabau for study. No reptile bones were found.

The base of the Dubshih is not exposed; its top passes under the typical fine red sands of the D'adokhta formation, marking an abrupt change in the character of the sediments. The entire exposure of the Dubshih formation occupies but twelve square miles. The faulting and tilting indicate a history similar to that of the Ochungchelo, Oshih and Ondai Sair units; and the position of the Dubshih beneath the Djadokhta formation suggests that it belongs to the Lower rather than to the Upper Cretaceous. It is, in part at least, equivalent to the Ochungchelo, but it is more complex and quite different in physical character as well as in fossil content. On these counts, it deserves special definition.

DOHOIN USU.—In 1925 Granger discovered a large basin of Cretaceous beds near the well, Dohoin Usu, at approximately Lat. 44° 14′ N., Long. 104° 19′ E., or 40 miles northeast of the eastern end of the Gurbun Saikhan range. He estimates that at least 300 feet of beds are exposed. The base of the formation was not seen, and the upper limit is the Gobi erosion plane, so that the original thickness must be greater than the present exposures. The sediments are chiefly brick red, sandy clays, exposed in badland bluffs along two promontories that front one another across a narrow intervening lowland.

The only fossils were found in a flat lens of bluish gray, sandy clay, 10 to 50 feet thick, in the red clay of the northern promontory. Granger collected pelecypod shells and bones of turtles, crocodilians and iguanodont dinosaurs—clearly a water-loving fauna. No sauropods were found, and the presence of iguanodonts suggests a relation with the Iren Dabasu biota rather than with that of Ondai Sair, Oshih, or Baiying Bologai. For this slender reason, and until the bones shall have been studied, we would place the Dohoin Usu formation near the Iren Dabasu in the column, without attempting any definite correlation.

TERTIARY FORMATIONS

In discussing the newer Tertiary deposits, it seems advisable to depart from the order of time sequence in a few cases so as to emphasize the structural relations of a locality. The individual formations are given their proper position in the geologic column, page 3. The first of the complex localities is the valley of Khunuk, east of the lake, Kholobolchi Nor.

THE KHOLOBOLCHI LAKE DISTRICT

KHOLOBOLCHI.—Possibly the oldest true Eocene beds thus far found belong to the Kholobolchi formation, outcropping at several places in the Khunuk Valley (Fig. 2).

The first section studied lies at the southern end of the Khunuk valley. Here a series of white and yellow arkosic sands and drab clays

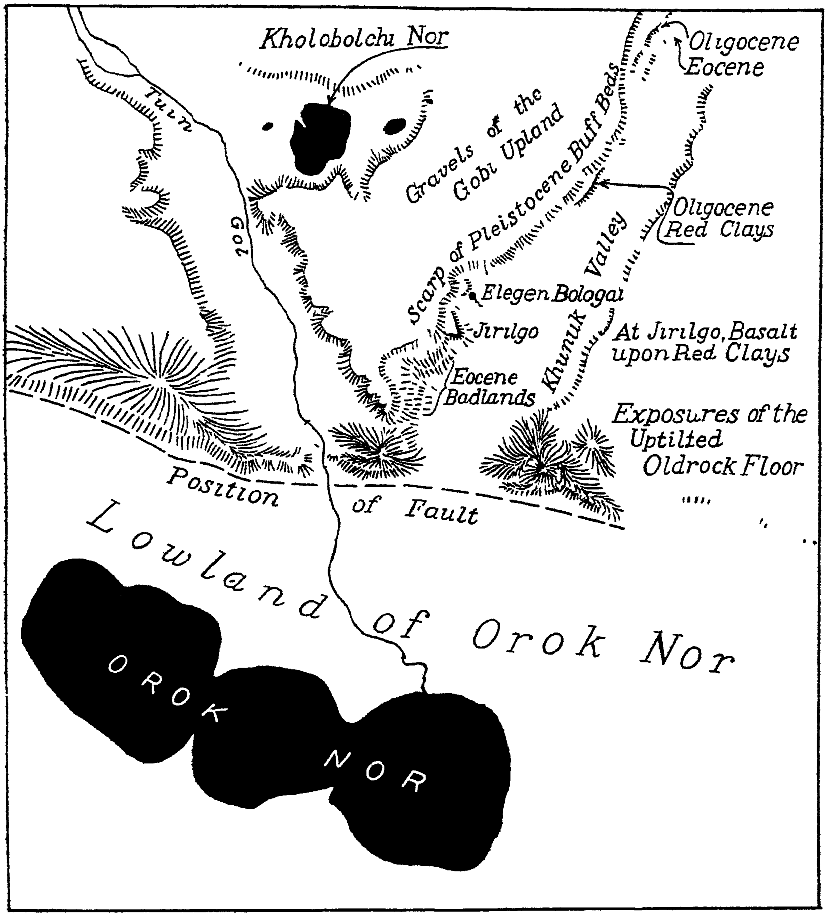

Fig. 2. Sketch map of the area between Kholobolchi Nor, Orok Nor, and Khunuk valley, showing (1) the faulted lowland or graben of Orok Nor, lying between the porphyry hills of the oldrock floor and the Altai range, Ikhe Bogdo, (2) the uptilted oldrock floor, exposed in the chain of porphyry hills; (3) the overlying Tertiary and Pleistocene sediments. (Based chiefly upon the survey by L. B. Roberts and F. B. Butler).

rests directly upon the planed surface of complexly folded rocks of undetermined age, belonging to the oldrock floor (Fig. 3). The later sediments dip northward, and are overlain by buff-colored sands, gravels and silts of Pleistocene age. The lower group of sediments is here between 200 and 300 feet thick, basing the calculation upon the dip and width of exposed outcrop. Skulls of coryphodonts and bones of other mammals were found here, indicating Eocene age, but until the bones are studied it will not be possible to compare the Kholobolchi beds with other formations. The biota is apparently different from any yet seen in Mongolia.

The same sediments can be traced northward for over 20 miles, as the lowest beds exposed in the Khunuk valley. The northern exposures, which are 157 feet thick, also yielded bones, chiefly of perissodactyls. The name, Kholobolchi formation, was assigned these beds, for, although their outcrops are several miles east of the lake, Kholobolchi Nor, the lake is known throughout the district and is the explorer's readiest guide in reaching them. The beds certainly extend beneath the lake itself.

KHUNUK.—The overlying buff beds (Fig. 3) range in thickness from 27 to 127 feet. Because they crown the bluffs along almost the entire west wall of the Khunuk valley (Fig. 2), they are called the Khunuk formation (pronounced Khoon-ook). They include fine buff silts, sandy clay or silt, and arkosic sands and gravels, commonly cross-bedded and locally cemented to form thin sandstones. The lower beds are of finer grain, while the sands and gravels increase in the higher portions. Some of the silty beds are very massive, and may well be windborne dust or loess. The cross-bedding in the sands and gravels is exclusively of stream type, with a prevailing southward dip, indicating that the source of the material was in the north—not in the Altai range to the south. Bones of horses, rhinoceros and a large mastodont clearly indicate Pleistocene age for the Khunuk formation.

OROK NOR.—The base of the Khunuk formation rests on a rolling erosion surface (Fig. 3). The top of the formation is capped by the familiar gravels of the Gobi upland, but as they are 5 to 10 feet thick here and yielded chipped flints which were studied by N. C. Nelson, it has seemed well to give them a name. Accordingly the name, Orok Nor formation, is assigned to the gravels above the Khunuk. The two are separated by a distinct plane where the contact could be seen, and the Orok Nor gravels, at least locally, show cross-bedding and channel-filling. As such washed gravels are not forming anywhere on the Gobi upland at the present time, and as the entire cutting of the Khunuk valley must have taken place since they were laid down, we judge that the upland gravels are of Pleistocene age. They belong to an epoch of deposition, separated from the present by an epoch of stream erosion.

Jirilgo (probably equivalent to the Hsanda Gol formation).—Three miles north of the southern exposures of the Khunuk buff beds, a new formation is found, intercalated lens-like between the Khunuk and the Kholobolchi (Fig. 3). It consists of massive red clay, without visible bedding, and attains a thickness of about 40 feet, thinning out, wedge-like, within less than a mile. It is capped by a flow of basalt, about 20 feet thick at most, which likewise thins out north and south. The basalt platform, on which the buff beds rest, is called Jirilgo by the Mongols, and we at first proposed this name for the associated red clays.

A little over two miles north of the Jirilgo lens, another lens of similar clay comes in, at the same horizon but without a basalt sheet. About two miles still farther north, red clays again appear, and attain a thickness of 62 feet. Here Granger found fossils which he considers belong to the Hsanda Gol fauna. As the red outcrops were traced eastward across the valley, and as the typical Hsanda Gol fossil-beds are exposed only 20 miles farther east, Granger proposed to call these beds also the Hsanda Gol, abandoning the field name of Jirilgo. But if the detailed study of the fauna should require a separate name for the red beds of Khunuk valley, the name Jirilgo should be retained as a convenient local name.

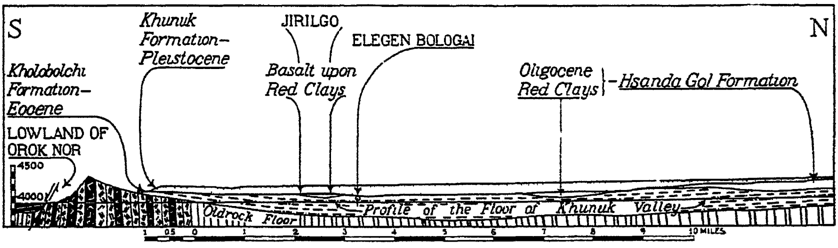

Fig. 3. Generalized geologic section along the western side of Khunuk valley. The vertical scale is five times the horizontal. The Orok Nor gravels are too thin to be plotted on this scale, and are represented by the line which bounds the top of the Khunuk formation. Where the northernmost exposure of the Hsanda Gol formation is indicated, the position of the problematic Elegen formation is indicated by a dotted line between the Hsanda Gol and the underlying Kholobolchi formations

Elegen.—At the northern badlands, we measured 70 feet of arkosic sands, gravels and clays, chiefly of gray color, with a few red layers, underneath the typical red Hsanda Gol clay and overlying the brown, drab clays and white and yellow sands of the Kholobolchi. No fossils were found in them, but they are sharply delimited from the Jirilgo (Hsanda Gol) red clays, and they are different from the Kholobolchi in texture, color, and details of erosion habit. In the field we considered that they might constitute a separate stratigraphic unit, and called them the Elegen formation, from the spring, Elegen Bologai.

If the beds prove to be a part of the Kholobolchi formation, the name, Elegen, must be abandoned, but we may retain it tentatively as the name for a group of beds that appears to form a distinct unit. In the field, it was the opinion of Morris that the Elegen should even include 35 feet of brown clays which lie at the top of the Kholobolchi formation. Bones were found in a channel filling of sand in the brown clays, the study of which will decide this question.

THE SHARA MURUN DISTRICT

At Shara Murun and Ula Usu, where Granger discovered fossil bones in 1922 and where the Expedition camped in 1923, two formations had been recognized—the lower Tukhum beds of hard red clay, distinguished by *Teilhardia pretiosa*, and the overlying Shara Murun beds of varicolored clays with a rich Upper Eocene fauna.[1] At that time, no detailed studies had been made of the eastern bluffs north of Baron Sog temple, or of the large red mesa north of the Tukhum lowland.

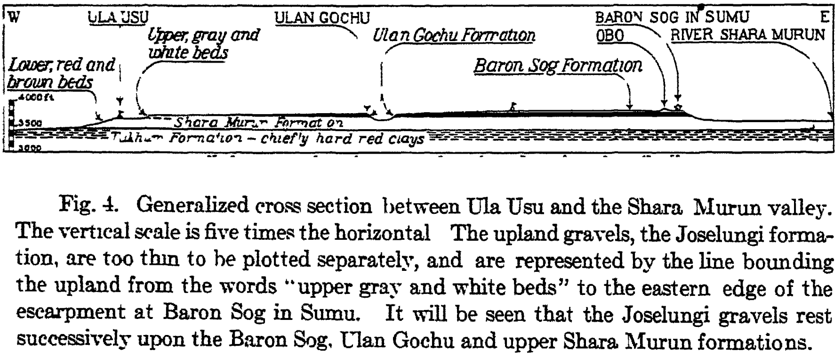

Fig. 4. Generalized cross section between Ula Usu and the Shara Murun valley. The vertical scale is five times the horizontal The upland gravels, the Joselungi formation, are too thin to be plotted separately, and are represented by the line bounding the upland from the words "upper gray and white beds" to the eastern edge of the escarpment at Baron Sog in Sumu. It will be seen that the Joselungi gravels rest successively upon the Baron Sog, Ulan Gochu and upper Shara Murun formations.

The base of the Shara Murun formation rests, with a clearly defined contact, upon the hard red clays of the Tukhum formation.

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[1] Matthew, W. D, and Granger, Walter 1926 'Two New Perissodactyls from the Arshanto Eocene of Mongolia' Amer Mus Novitates, No 208. Berkey, C P, and Morris, F. K. 1927. Geology of Mongolia, pp 346, 367

ULAN GOCHU.—Traced eastward along the northward-facing front of the scarp, the typical light-colored clays and sands of the upper Shara Murun formation pass beneath a wedge-shaped mass of red clay which ranges from only two feet in thickness where it first becomes visible, to 60 feet at a bold bluff called Ulan Gochu (Fig. 4). In 1925, Granger found fossils in the red clays exposed in the badlands east of Ulan Gochu. The fossils are of Oligocene age, and include titanotheres and some new perissodactyl genera. The red beds continue eastward and southward along the front of the bluff (Figs. 1 and 4) for at least four miles from Ulan Gochu.

BARON SOG.—Overlying the red clays are light gray clays and fine cross-bedded sands. Some beds contain white marly concretions. Like the Ulan Gochu, the gray beds thin out westward and disappear, while they can be traced indefinitely toward the east and south (Fig. 4). The temple, Baron Sog in Sumu, and the large obo of the same name are built upon the gray formation, and it seems well to define it as the Baron Sog formation. Granger found in this formation an Oligocene titanothere fauna of younger aspect than that of the Ulan Gochu. The greatest thickness measured by the geologists is 27 feet, but in the poorly exposed portions toward the east and south, it is probably thicker. The Baron Sog rests with a clear-cut, smooth contact upon the red Ulan Gochu, and is overlain by the gravels of the Gobi upland.

JOSELUNGI.—These Gobi upland gravels are themselves crossbedded and show channel fillings. They are clearly stream deposits, but no streams are possible on the upland now; they must have been laid down before the deep and wide lowlands of Tukhum and Shara Murun were excavated (Fig. 4).

We judge the upland gravels to be of Pleistocene and possibly in part of Pliocene age; they are locally as much as 12 feet thick. It is not impossible that fossils may be found in them and thus define them more clearly. They form a superficial structural unit for which the name of the upland, Joselungi, may be proposed. It is possible that this superficial deposit does not deserve a definite formational name.

As shown in the section (Fig. 4), the Joselungi gravels rest successively on the Baron Sog, the Ulan Gochu, and the Shara Murun formations, lying on an erosion surface that bevels them all.

ULAN SHIREH (probably equivalent to the Tukhum formation).—North of the bluffs that include the formations just mentioned, there is a system of broad lowlands which has been but slightly investigated.

The eastern portion of the streamless lowland of Tukhum is tributary to the valley of the Shara Murun, an active though shrunken river.

No fossils have been found in either lowland, although there are exposures near the foot of the bluff. North of the Tukhum lowland, there is a red-cliffed mesa called Ulan Shireh, and here, in 1925, rich fossil beds were discovered. The beds are dominantly red clays, though gray clays, sands, and gravels were seen in the western part of the mesa. They form a distinct physical unit. The visible thickness is at least 150 feet (the base has not been seen) and the upper limit is the Gobi erosion plane. Correlation with the formations of the southern bluff must await the determination of the fossils. For the present the name Ulan Shireh is proposed.

East of the Shara Murun valley the sediment basin continues for over 50 miles to the place where the granites and graywackes of the old-rock floor become visible at Boltai U[illegible]tu. Splendid exposures in cliffs have been seen at a distance, to the east. These were examined in 1928, and the sequence was found to be the same as on the Baron Sog Mesa.

TSAGAN NURU.—At the Hung Kureh, Granger reports that the huge mastodon pelvis was found in white sands and clays that fill a channel carved in the typical Hung Kureh beds. This fact of superposition indicates post-Hung Kureh age, and the mastodon, according to Granger, is of a Pleistocene type. The geologists did not visit the site of Granger's discovery, and the question of whether the channel filling is to be correlated with the Gochu remains unsolved. The bluffs are called Tsagan Nuru by the Mongols, and we, therefore, assigned this name to the Pleistocene sands and clays. The sediments are strikingly different from the heavy dark rubbles of the Gochu formation already reported, and the name, Tsagan Nuru, will probably stand the test of future investigations.

In concluding this brief review, it is noteworthy that every period except the Miocene represented by the so-called "later" sediments has added new horizons. The Miocene, as in our earlier studies, has slight representation in the record of the later sediments. Unless subsequent expeditions discover more Miocene formations, our earlier inference, that the Miocene was characterized by widespread erosion, will be strengthened.[1]

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[1] Berkey, C. P., and Morris, F K 1927 Geology of Mongolia, pp 346, 367

AMERICAN MUSEUM NOVITATES

Number 386 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Nov. 27, 1929

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NEW SPECIES OF *PALAMINUS* FROM THE WEST INDIES, TOGETHER WITH A SYNOPTIC REVIEW OF THE GENUS

BY HOWARD NOTMAN

One hundred and three species of *Palaminus* and one variety are listed in the 'Coleopterorum Catalogus' of Junk and Schenkling (1912, part 40, pp. 198–201). Thirty-three additional species have been described since the publication of that work. Eight species are described as new in this paper. A synopsis of the North American species was published by LeConte in his paper on the 'Coleoptera of Florida' (1878, Proc. Amer. Philo. Soc., XVIII, pp. 396, 397). Sharp divides the species described by him in the 'Biologia Centrali-Americana' (Coleoptera, I, part 2, pp. 631–639) into two groups, by the form of the apical antennal joints. In Group I, the apical joint is not distinctly wider than the penultimate; in Group II, the apical joint is distinctly wider than the penultimate. Casey ('Mem. Col.,' I, pp. 197–200) describes and tabulates a number of species allied to *P. contortus* LeConte and *P. testaceus* Erichson using the genitalic characters of the female only.

The species of *Palaminus* divide rather satisfactorily on color-characters, the darker colored species ranging from rufous or ferruginous to black in one group and the lighter colored species of various shades of testaceous in a second. In general, the dark-colored species are maculate and the pale species are immaculate. There are, however, twenty-one black or piceous species which are immaculate and thirteen pale species which are maculate. In the pale species the abdomen is usually slightly darker; in *P. atriventris* Bernhauer the abdomen is black.

Other characters used in separating species are as follows: the presence or absence of the tempora of the head; the proportions of the head, thorax and elytra; the presence and degree of distinctness of a medio-basal carination of the thorax; the punctuation of the head, thorax and elytra. The thoracic punctures are occasionally distinctly seriate either side of the median line.

Of the species included in the synopsis one only requires particular mention in regard to its position: *novæ-guineæ* Fauvel is placed with species in which the thorax is quadrate or nearly so although the description gives no clue whatever to the proportions.

The material from Porto Rico was collected in connection with the N. Y. Academy survey of that Island. Types are deposited in The American Museum of Natural History.

SYNOPSIS OF THE SPECIES OF *Palaminus*

1. Dark-colored species, piceous or black, immaculate and unicolorous . . . 2.
   Species not so colored . . . . 22.
2. Color brownish or piceous; thorax transverse . . . . . . 3.
   Color black . . . . 4.
3. Thorax more strongly narrowed posteriorly with distinct, smooth, median carinulation; head broader than thorax; length, 4.1 mm. . . *piceus* Erichson.
   Thorax less strongly narrowed posteriorly with median carinulation indistinct and punctures longitudinally seriate either side; length, 4.25 mm. *brunneus* Fauvel.
4. Thorax longer than wide; length, 7.5 mm. . . . . . *longicollis* Sharp.
   Thorax not longer than wide. . . . . 5.
5. Thorax as long as wide . . . . 6.
   Thorax transverse . . . . 16.
6. Head wider than thorax . . . . 7.
   Head not wider than thorax . . . . 10.
7. Thoracic punctures coarser and more or less seriate . . . . . . 8.
   Thoracic punctures sparse and not seriate . . . . 9.
8. Thoracic punctures more numerous, in four distinct series on the disc, the inner series shorter; elytra more closely punctate basally; length, 5.1 mm . . . . *parcus* Sharp.
   Thoracic punctures less numerous, two distinct series on the disc; elytra less closely punctate basally; length 5.1 mm . . . . *pellax* Sharp.
9. Form narrower; elytra less closely punctate; length, 6.1 mm. . . *fuscipes* Sharp.
   Form broader; elytra more closely punctate; length, 6.6 mm. . . . *stipes* Sharp.
10. Elytra longer, twice as long as thorax . . . . 11.
    Elytra shorter, but little more than one and a half times as long as thorax or less . . . . 13.
11. Smaller species; length, 6 mm.; head and thorax proportionally narrower. *parviceps* Sharp.
    Larger species; length, 8–8½ mm . . . . 12.
12. Thorax narrower, one-half the width of the elytra; punctures very coarse and irregular; length, 8 mm . . . . *lacertinus* Sharp.
    Thorax broader; punctures of head and thorax less close and deep; head with tempora; anterior tibiæ and tarsi broader; length, 8.5 mm. . . *validus* Sharp.
13. Thorax with sides more distinctly rounded and less narrowed posteriorly; elytra rather more finely and closely punctate . . . . 14.
    Thorax with sides scarcely or not at all rounded, much narrowed posteriorly . 15.
14. Thorax more coarsely and distinctly punctate, punctures irregularly, longitudinally biseriate on disc; length, 6.1 mm . . . . *anceps* Sharp.
    Thorax sparsely, irregularly and subobsoletely punctate; elytra more than one and one-half times the length of thorax, the latter one-half narrower; length, 6.1 mm . . . . *pilosus* Erichson,

15. Head less closely punctate; sides of thorax very slightly arcuate; punctures somewhat seriate on disc, series coalescent posteriorly with medio-basal smooth area greatly reduced; length, 6.1 mm...... . . *niger* Sharp.
Head more closely punctate; sides of thorax absolutely straight, disc closely punctate with distinct medio-basal smooth subcarinate area; length, 5.1 mm......... ....*sobrinus* Sharp.
16. Head narrower than thorax, tempora distinct; elytra nearly twice as long as thorax, somewhat rugosely punctate; length, 5.5–6 mm.
morosus Cameron.
Head not narrower than thorax............... .... .17.
17. Last two abdominal segments crenate-punctate basally; thorax distinctly bi-impressed basally; head nearly as wide as elytra; length, 7.5 mm.
crenatus Sharp.
Last two abdominal segments not crenate-punctate basally ... .18.
18. Thorax densely and almost regularly punctate; antennæ short and unusually stout; elytra densely punctate; length, 5 mm.. ....*mexicanus* Sharp.
Thorax more sparsely or irregularly punctate, usually with a medio-basal longitudinal smooth line.... . . .. .19.
19. Thoracic punctures sparse..... ... . .20.
Thoracic punctures coarse and close, medio-basal, longitudinal smooth area distinct; sides of thorax moderately narrowered posteriorly..........21.
20. Thorax subobsoletely punctate with three distinct smooth areas; elytra distinctly less than twice as long as thorax; length, 8 mm...*cognatus* Sharp.
Thoracic punctures coarse and sparse; head wider than thorax; elytra fully twice as long as thorax; apical antennal joint longer than three preceding combined; length, 5 mm........... ....*tortilis* Casey.
21. Head not wider than thorax; thorax with distinct medio-basal longitudinal carinulation; male—6th ventral abdominal segment with asymmetrical apical prolongation; length, 7 mm....................*concolor* Sharp.
Head slightly wider than thorax; thorax bi-impressed at base, impressions coarsely and closely punctate, medio-basal smooth area distinct; elytra more than one and one-half times the length of thorax; male—no distinct modification of 6th ventral abdominal segment; length, 4.73 mm.
puncticeps Sharp.
22. Color black, head, thorax and elytra rufo-testaceous; head without tempora; thorax transverse; length, 4 mm............. ...*atriventris* Bernhauer.
Color not as above........................ ....23.
23. Color darker; rufous, castaneous or ferruginous species sometimes immaculate; piceous or black species always maculate, vittate, bicolored (elytra pale) or with elytral margins in part at least distinctly paler...............24.
Color not as above.. ....73.
24. Elytra not longer than thorax...................... ....25.
Elytra longer than thorax......... ....27.
25. Color piceous, elytra paler; thorax as long as wide; length, 3.4 mm.
flavipennis LeConte.
Color black, elytra maculate......................................26.
26. Head wider than thorax; thorax transverse; elytral maculation cruciform; length, 6 mm......................... . .. ...*pictus* Bernhauer.

Head as wide as thorax; thorax longer than wide; elytra shorter than thorax, broadly yellow laterally; length, 4–4.5 mm.......*variiventris* Bernhauer.

27. Color piceous, elytra with suture (except at base) and apical margins paler, rufous; head as wide as thorax, the latter transverse; elytra twice as long as thorax; length, 5 mm. ..truncatus Fauvel.

Color not as above.......................................28.

28. Color black, elytra maculate with yellow on disc, or elytra yellow maculate with black.......................................29.

Color or maculation not as above.......................................34.

29. Color black, elytra yellow with large black discal spot reaching the base; head as wide as thorax, the latter transverse, with small denticulation on either side at posterior third; elytra one-half longer than thorax; length, 5 mm. *erichsoni* Bernhauer.

Color or maculation not as above.......................................30.

30. Color black, elytra each with two yellow spots.......................................31.

Color black, elytra each with one yellow spot.......................................32.

31. Thorax slightly transverse, sides less rounded, posterior angles distinct; anterior spot elongate, oblique; length, 5.5 mm. *quadripustulatus* Bernhauer.

Thorax as wide as long, ovate, almost globose; anterior spot round, its position more median; length, 6.5 mm...............*quadriguttatus* Fauvel.

32. Thorax longer than wide; elytra with a broad spot on posterior half; elytra twice as long as thorax; length, 6.5 mm .... *plagiatus* Fauvel.

Thorax not longer than wide.......................................33.

33. Elytral spot small, near lateral margin at posterior one-third; head larger; length, 6.5 mm.......................*biguttatus* Fauvel.

Elytral spot extending from lateral margin almost to suture, emarginate posteriorly; head smaller; length, 7 mm.......*bipustulatus* Bernhauer.

34. Color rufo-ferruginous, elytral apices paler.......................................35.

Color or maculation not as above.......................................36.

35. Head wider than thorax; thorax transverse; elytra twice as long as thorax and much wider; length, 3.55 mm.............*ferrugineus* Sahlberg.

Head as wide as thorax; thorax transverse; elytra one-halt longer than thorax; length, 3.55 mm...............................*apicalis* Sharp.

36. Color black, outer apical angles of elytra broadly obliquely yellow; head as wide as thorax; thorax as wide as long; elytra twice as long as thorax; length, 6 mm..............................*sharpi* Bernhauer.

Color or maculation not as above.......................................37.

37. Color black or blackish, elytra with apical margins evenly and distinctly pale.......................................38.

Color or maculation not as above.......................................44.

38. Head narrower than thorax.......................................39.

Head wider than thorax.......................................40.

39. Thorax longer than wide; elytra a little more than one-half longer than thorax; elytral apices narrowly straw-yellow; length, 5.4 mm..*gracilis* Sharp.

Thorax transverse, small, evidently narrower than elytra; eyes rather small, head with distinct tempora; length, 5 mm...........*apicipennis*[1] Sharp.

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[1] For comment on the size of the head in this species, see the description of *Palaminus apicatus* Bernhauer.

40. Elytra shorter, one-half longer than thorax; thorax transverse; length, 5.4 mm. *distans* Sharp.

Elytra longer, about twice as long as thorax.. ... .41.

41. Thorax as wide as long, much narrowed posteriorly, much narrower than elytra length, 5 mm.... ....*insignis* Sharp.

Thorax transverse.. . ... 42.

42. Thorax with sides nearly straight and very strongly narrowed posteriorly; length, 4.5 mm.... ....*trapezicollis* Bernhauer.

Thorax with sides distinctly arcuate.. . ...43.

43. Thorax without distinct, impunctate, more or less elevated areas in anterior angles; elytra black with apical margins yellowish; head almost broader than elytra; elytra not quite twice as long as thorax; length, 4 mm. *apicatus* Bernhauer.

Thorax with distinct, impunctate, more or less elevated areas in anterior angles; elytra black with apical margins piceous; elytra almost twice as long as thorax; length, 4.5 mm................ ....*bonariensis* Lynch.

44. Color castaneous, ferruginous, rufo-piceous or piceous with paler maculation always more or less distinctly vittaform...... .... .45.

Color or maculation not as above.......... .. ..52.

45. Thorax with disc strongly rugose, rugosities oblique, thorax transverse; elytral maculation less distinctly vittaform, consisting of humeral and apical spots sometimes coalescent; length, 3.5 mm... . .*rugicollis* Fauvel.

Thorax with disc not rugose...................... . . . . . . .46.

46. Elytra with a subhumeral vittaform spot and apex pale.. . .... . .47.

Elytra with a subhumeral vittaform spot only or the lateral margin pale.. .49.

47. Elytra densely, finely, subrugosely punctate, twice as wide as thorax; thorax scarcely transverse; length, 3.5 mm... .... *circumflexus* Fauvel.

Elytra coarsely and closely punctate, a little wider than thorax; thorax more distinctly transverse...48.

48. Form more elongate; thorax less transverse; elytra with humeral vittæ reaching apex; length, 5 mm....................... . ...*vittatus* Sharp.

Form less elongate; thorax more transverse; elytra with humeral vittæ not reaching apex; length, 4.5 mm... .... .var. *humeralis* Sharp.

49. Elytra with lateral margins pale..... ....50.

Elytra with subhumeral vittaform pale spot.. .... .51.

50. Size smaller; elytra longer, twice or more or long as thorax; thorax closely and strongly punctate; elytra piceous, the paler lateral margins piceous brown; length, 3 mm............................ ...*productus* Schubert.

Size larger; elytra shorter, about one-half longer than thorax; thorax with discal punctures biseriate; elytra piceous with lateral margins broadly testaceous; head wider than thorax, the latter transverse and much narrowed posteriorly; length, 6.1 mm.......... ......*sellatus* Sharp.

51. Head scarcely wider than thorax; thorax one-third wider than long with a medio-basal smooth carinulation, sides broadly arcuate and feebly narrowed posteriorly; elytra wider and three-fourths longer than thorax; length, 3.4 mm..........*signifer* Casey (*asymmetricus* Bernhauer).[1]

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[1] These are probably synonyms; there is nothing in the description to distinguish them apart.

52. Color castaneous, elytra black with castaneous maculation; thorax transverse; elytra much wider and twice as long as thorax; length, 5–6 mm. *bivittipennis* Lea.

Color rufous, elytra often maculate with darker; black or ferruginous with elytra sometimes paler, either immaculate or with suture infuscate. . . . 53.

53. Elytra maculate. . . . . 54.

Elytra immaculate or narrowly infuscate suturally. . . . . 58.

54. Sides of thorax with blackish vittæ; sides and suture of elytra with narrow blackish vittæ; thorax as wide as long; elytra much longer than wide; length, 4.5 mm. . . . . *trivittipennis* Lea.

Sides of thorax without blackish vittæ. . . . . 55.

55. Elytra with suture and apical margins nigro-piceous; subhumeral vitta of same color; elytra one-third wider and twice as long as thorax, punctuation asperate and subrugose; head slightly wider than thorax; length, 6 mm. *vitiensis* Fauvel.

Elytra with apical margins not darker. . . . . 56.

56. Elytra with suture narrowly somewhat darker; thorax subquadrate; color rufo-piceous; thorax subcarinate medio-basally; elytra twice as long as thorax; length, 5 mm. . . . . *suturalis* Fauvel.

Elytra with large triangular or trilobate common spot . . . . 57.

57. Thorax transverse; elytra with a common subtriangular dark spot; length, 4 mm. . . . . *lancifer* Fauvel.

Thorax transverse; elytra one-third longer than thorax, with common trilobate dark spot; length, 5 mm. . . . . *heraldicus* Fauvel.

58. Color rufous or ferruginous, immaculate; elytra sometimes slightly paler. . 59.

Color black, piceous-black or ferruginous, elytra always distinctly paler. . . . 68.

59. Head and thorax densely rugulose-punctate; head as wide as thorax; thorax transverse; elytra less than one-half longer than thorax, paler in color; length, 3.5 mm. . . . . *opaculus* Bernhauer.

Head and thorax not rugulose-punctate. . . . . 60.

60. Thorax transverse. . . . . 61.

Thorax about as long as broad . . . . 64.

61. Head wider than thorax, tempora distinct; thorax with sides slightly arcuate, strongly narrowed posteriorly; elytra one-half longer than thorax, slightly paler in color; length, 5.1 mm. . . . . *crassus* Sharp.

Head not wider than thorax. . . . . 62.

62. Head with distinct tempora; thorax with sides arcuate, much narrowed posteriorly; elytra one-half longer than thorax; length, 5.6 mm. *longicornis* Sharp.

Head without tempora. . . . . 63.

63. Thorax densely punctate, basal impressions and medio-basal smooth area not distinct; male—6th ventral abdominal segment sharply tri-emarginate apically; length, 4.5 mm. . . . . *compressiventris* Bernhauer.

Thorax bi-impressed on disc, impressions coarsely and somewhat densely punctate with flat, rather indistinct medio-basal smooth area; male—6th ventral abdominal segment with four apical teeth of unequal length; length, 3.5 mm. . . . . *spiniventris* Bernhauer.

64. Base of head scarcely or not emarginate medially. . . . . 65.

Base of head distinctly emarginate medially. . . . . 66.

65. Thorax with sides strongly narrowed posteriorly; elytra one-third longer than thorax; length, 4 mm.. ....*nossibianus* Fauvel.
Thorax with sides slightly narrowed posteriorly, strongly arcuate; elytra nearly one-half longer than thorax; length, 5.1 mm.. . ...*modestus* Sharp.

66. Head with distinct tempora, basal angles strongly denticulate; thorax with sides strongly narrowed posteriorly, basal smooth carinulation distinct, bi-impressed either side; length, 3.25 mm.......... .*pennifer* Fauvel.
Head without tempora.......... . ...67.

67. Thorax with sides but little narrowed posteriorly, scarcely impressed either side of medio-basal carinulation; elytra often rufo-testaceous; length, 4.5 mm. *madecassa* Fauvel.
Thorax with sides strongly narrowed posteriorly; length, 3.25–3.35 mm. *allocerus* Fauvel.

68. Elytra infuscate suturally.. ....69.
Elytra not infuscate suturally.... ....70.

69. Thorax as long as wide, strongly narrowed posteriorly; antennæ with terminal joint more slender, scarcely wider than preceding; color ferruginous, elytra testaceous; head much narrower than elytra; thorax as wide as long; elytra slightly less than twice as long as thorax; length, 6 mm. *gracilipes* Sharp.
Thorax transverse, sides arcuate, much narrowed posteriorly; antennæ with terminal joint stout, distinctly wider than preceding; head nuch narrower than elytra, tempora distinct; abdomen infuscate subapically; length, 5 mm.......... ....*sordidus* Sharp.

70. Thorax scarcely transverse; color dark piceous, elytra piceo-testaceous or rufous; elytra one-half as long as thorax; length, 4.1 mm. *pallipes* LeConte.
Thorax strongly transverse; elytra twice as long as thorax....... ....71.

71. Color black, elytra rufous; head not much narrower than elytra; thorax closely and coarsely punctate and unimpressed; male—6th ventral abdominal segment, strongly asymmetrically produced; length, 7 mm. *rubripennis* Sharp.
Color ferruginous, elytra testaceous ... . .72.

72. Form stouter; size larger; head and thorax more coarsely and closely punctate; head as wide as thorax; thorax with a smooth medio-basal carinulation, coarsely and densely punctate either side, more sparsely laterally; male—6th ventral abdominal segment emarginate medially; length, 5.2–5.5 mm....... ....*bolivianus* Bernhauer.
Form more slender; size smaller; head and thorax less coarsely and closely punctate; male—6th ventral abdominal segment feebly emarginate throughout its width; length, 4 mm... ....*balzani* Bernhauer.

73. Color rufo-testaceous with black or blackish maculation or sutural infuscation.......... ....74.
Color rufo-, ferrugineo-, castaneo-, or piceo-testaceous or testaceous, immaculate, abdomen slightly darker.................... ....87.

74. Thorax much longer than wide; head wider than thorax; elytra twice as long as thorax; a broad sutural vitta on elytra and abdomen subapically blackish; length, 5.5–6 mm..... ....*vittiger* Bernhauer.
Thorax not longer than wide...... . . ..75.

75. Elytra with three black vittæ on posterior half; thorax transverse, narrower and much shorter than elytra; length, 4.5 mm.....*evansi* Bernhauer.
Elytra not maculate as above.................................76.

76. Elytra blackish, suture, apical margins and elongate humeral spots testaceous; head as wide as thorax; thorax slightly transverse, with disc unimpressed; length, 3–3.5 mm..........................*maculatus* Bernhauer.
Elytra not maculate as above...............................77.

77. Elytra with suture more or less distinctly infuscate ....78.
Elytra with suture not infuscate...............................84.

78. Abdomen subapically blackish...............................79.
Abdomen not subapically blackish; suture feebly infuscate..............80.

79. Elytra with discal spot behind middle, narrowly infuscate suturally and along inflexed lateral margins; elytra one-half wider and longer than thorax; head with distinct tempora; length, 3.75 mm........*lengi*, new species.
Elytra without discal spot, sutural vitta black; head wider than thorax; thorax strongly transverse; elytra scarcely twice as long as thorax (on suture); length, 4.2 mm.............................*pauloënsis* Bernhauer.

80. Head smaller, not wider than thorax; elytra with feeble sutural infuscation.81.
Head larger, wider than thorax; sides of thorax strongly narrowed posteriorly...83.

81. Thorax as long as wide; sides not arcuate, much narrowed posteriorly; head with short but distinct tempora; elytra considerably broader than thorax and one-half longer; length, 5.1–5.6 mm............*simplex* Sharp.
Thorax rather strongly transverse; head without tempora..............82.

82. Size smaller, 4 mm.; elytra larger, much wider than thorax and twice as long; male—6th ventral abdominal segment produced medially, lobe strongly twisted to left with minute tooth either side..........*debilis* Sharp.
Size larger, 4.73 mm.; elytra smaller, a little wider than thorax and one-half longer; sutural infuscation more apical; thorax with small and narrow medio-basal smooth area...........................*discretus* Sharp.

83. Thorax less transverse, one-fourth wider than long; elytra with feeble sutural infuscation; length, 4.3–4.7 mm................*isthmianus* Casey.
Thorax more transverse, one-third wider than long; elytra broadly piceous along suture from base nearly to apex; length, 3.2 mm. (contracted).
tegulatus Casey.

84. Elytra with reflexed lateral margins black; head wider than thorax; thorax slightly transverse; length, 5 mm..................*lateralis* Cameron.
Elytra with outer apical angles black or infuscate.....................85.

85. Thorax not darker laterally; outer apical angles of elytra infuscate; head slightly wider than thorax; thorax more than a fourth wider than long, much narrower than elytra; elytra more than twice as long as thorax; male—6th ventral abdominal segment strongly produced and tri-emarginate; length, 3–3.2 mm. ....*infuscatus* Bernhauer.
Thorax darker laterally..86.

86. Size smaller, 3 mm.; head with post-ocular region black, wider than thorax, eyes very large; thorax sharply and narrowly black laterally.
fijiënsis Cameron.

Size larger, 5.5 mm.; post-ocular region of head not black; head as wide as thorax, tempora not distinct; thorax feebly infuscate laterally. *limbifer* Fauvel.

87. Elytra not longer than thorax.. .. ..88.

Elytra much longer than thorax, rarely only a little longer. .... ..90.

88. Thorax very slightly longer than wide, sides strongly narrowed posteriorly; length, 3.1 mm... . ...*larvalis* LeConte.

Thorax distinctly transverse.. . .. .89.

89. Head larger, wider than thorax; length, 2.8 mm. . . . .*apterus* Bernhauer.

Head smaller, not wider than thorax; length, 3.5 mm. ....*simoni* Fauvel.

90. Thorax distinctly alutaceous.......... ....91.

Thorax not alutaceous but sometimes densely punctate.. . .. .99.

91. Head wider than thorax........... ....92.

Head not wider than thorax; thorax transverse... ....96.

92. Elytra longer, twice as long as thorax; thorax transverse; male—6th ventral abdominal segment without asymmetrical apical ligula; sculpture sparse and obsolete; length, 2.9–3.3 mm...... ....*coriaceus* Cameron.

Elytra shorter, one-fourth to one-half longer than thorax; thorax without median carinulation or impunctate area...............................93.

93. Head with distinct tempora.... .... .94.

Head without distinct tempora.......... .... .95.

94. Thorax widest at middle, sides arcuate, scarcely more convergent basally than apically, two-fifths wider than long; elytra one-third wider and less than one-half longer than thorax; male—6th ventral abdominal segment with long asymmetrical ligula; length, 3–3.5 mm...*parvipennis*, new species.

Thorax widest near apical third, sides arcuate and strongly narrowed to base, one-third wider than long; elytra one-third wider and longer than thorax; male—6th ventral abdominal segment with acuminate, symmetrical ligula which is bifid at apex; length, 2.5 mm.......*bifidus*, new species.

95. Thorax distinctly transverse, one-third wider than long, sides arcuate, widest at apical fourth, distinctly narrowed posteriorly; elytra a little wider and one-fourth longer than thorax; length, 2.5 mm.....*scitulus*, new species.

Thorax scarcely transverse, one-fifth wider than long, widest at apical fourth, sides feebly arcuate and rather strongly narrowed posteriorly; elytra one-third wider and one-half longer than thorax; length, 2.75 mm. *pusillus*, new species.

96. Head without distinct tempora; thorax less transverse, one-third wider than long, rather strongly alutaceous, punctuation more distinct; elytra twice as long as thorax; length, 3 mm...........*aluticollis* Bernhauer.

Head with distinct tempora...97.

97. Thorax with distinct medio-basal carinulation, less strongly alutaceous and less distinctly punctate, with a lateral denticulation; elytra larger, distinctly wider than thorax and twice as long; form less slender; thorax much more sparsely punctate than head; length, 3.2 mm.....*barbiellinii* Bernhauer.

Thorax without medio-basal carinulation......... ....98.

98. Elytra much shorter, scarcely more than one-fourth longer than thorax, a little wider; thorax not quite one-half wider than long, widest at apical third, sides not more convergent basally than apically, strongly alutaceous, punctures indistinct; length, 2.9 mm...........*grandicollis*, new species.

Elytra much longer, twice as long as thorax, scarcely wider; form slender and parallel; thorax with sides very little narrowed posteriorly; length, 3.5 mm. . . . . *diffinis* Sharp.

99. Thorax as long as wide or nearly so . . . . 100.

Thorax transverse. . . . . 109.

100. Head with tempora obsolete or nearly so. . . . . . . 101.

Head with distinct tempora. . . . . 103.

101. Elytra shorter, less than one-third longer than thorax, scarcely longer than wide; length, 3.33–3.5 mm. . . . . *transmarinus* Fauvel.

Elytra longer, twice as long as thorax, the latter with sides straight and much narrowed. . . . . 102.

102. Head larger, as wide as elytra at humeri; length, 4 mm. (extended). *tener* Bernhauer.

Head smaller, narrower than elytra; length, 2.75 mm. *philippinus* Bernhauer.

103. Elytra longer, twice or more as long as thorax; thorax coarsely and densely punctate, sides strongly and subrectilinearly narrowed posteriorly; elytra finely punctate; last joint of antennæ short, subequal to tenth; length, 4 mm. . . . . *densicollis* Bernhauer.

Elytra shorter, scarcely more than one-half longer than thorax, often but slightly longer. . . . . 104.

104. Elytra about one-third to one-half longer than thorax . . . 105.

Elytra only slightly longer than thorax. . . . . 107.

105. Sides of thorax straight, much narrowed posteriorly; head as wide as thorax; thorax much narrower than elytra, not distinctly impressed but with median smooth area; male—6th ventral abdominal segment feebly, broadly produced, broadly trisinuate; length, 4.1 mm. . . *sinuatus* Sharp.

Sides of thorax somewhat arcuate . . . . 106.

106. Sides of thorax much narrowed posteriorly; head wider than thorax; thorax much narrower than elytra, disc bi-impressed, sparsely but strongly punctate; length, 3 mm. . . . . *pallidus* Sahlberg.

Sides of thorax only slightly narrowed posteriorly; head scarcely wider than thorax; elytra one-third longer than thorax; transversely subcrenately punctate; length, 4 mm. . . . . *novæ-guineæ* Fauvel.

107. Thorax much more narrowed posteriorly, sides arcuate; elytral punctuation coarse but not sparse; length, 2.8 mm. . . . . *cribratus* LeConte.

Thorax less narrowed posteriorly; elytra more finely punctate. . . . . 108.

108. Elytral punctuation closer and finer; length, 2.1 mm. . . . . . . *pumilus* LeConte.

Elytral punctuation sparser and croarser; length, 3 mm. . . . *lividus* LeConte.

109. Head distinctly narrower than thorax. . . . . 110.

Head not narrower than thorax. . . . . 117.

110. Head with distinct tempora; thorax with sides distinctly arcuate. . . . . 111.

Head without tempora. . . . . 113.

111. Elytra shorter, one-third longer than thorax; thorax with disc scarcely impressed; abdomen with 6th segment strongly punctate; length, 4 mm. *australiæ* Fauvel.

Elytra longer, about twice as long as thorax. . . . . 112.

112. Size larger, 5 mm.; punctuation of thorax sparser, discal impressions feebler; elytra longer; male—6th ventral abdominal segment apically produced with a small but distinct, semicircular emargination at apex. *thiemi* Bernhauer.

Size smaller, scarcely 4 mm.; punctuation of thorax denser, discal impressions of thorax stronger; elytra shorter; male—6th ventral abdominal segment feebly produced, deeply emarginate for nearly the full width of the segment. *columbinus* Bernhauer.

113. Elytra shorter, not more than one-half longer than thorax . . . . . . 114.

Elytra longer, about twice as long as thorax....... ... ... 115.

114. Size larger, 6.1 mm.; thorax more closely punctate, smooth areas subobsolete; thorax a little narrower than elytra.... ... .*robustus* Sharp.

Size smaller, 3 mm.; thorax more sparsely punctate, smooth areas dilated, prominent; thorax much narrower than elytra .... *minor* Bernhauer.

115. Thorax slightly transverse; male—6th ventral abdominal segment broadly symmetrically produced; thorax much narrower than elytra; length, 4 mm.. .... *parvulus* Sharp.

Thorax strongly transverse; male—6th ventral abdominal segment asymmetrically produced at middle....... .... .116.

116. Form broader; punctuation more dense; male—6th ventral abdominal segment with median ligula longer with a spine on the left side; length, 4 mm. .. ..*deformis* Sharp.

Form more slender; punctuation more sparse; male—6th ventral abdominal segment with ligula shorter, without spine, apex acute on left side rounded on right; length, 4 mm..... .. . . *chiriquensis* Sharp.

117. Head distinctly wider than thorax.. .. . . 118.

Head about as wide as thorax... . . . . 127.

118. Elytra shorter, one-third to one-half longer than thorax. . ... 119.

Elytra longer about twice as long as thorax.......................... ..122.

119. Sides of thorax distinctly arcuate, distinctly but not strongly narrowed posteriorly, thorax one-third wider than long, widest at apical fourth, with distinct medio-basal carinulation; elytra one-third wider and longer than thorax; length, 2.35 mm......... . . . . *dubius*, new species.

Sides of thorax subrectilinear........... .. .. 120.

120. Thorax more closely punctate, slightly transverse; elytra coarsely, closely and rugulosely punctate; length, 3 mm....... .... .*samoensis* Cameron.

Thorax more sparsely punctate........... ....121.

121. Thorax slightly transverse, widest at the anterior angles; antennæ with first three joints equal in length, 11th as long as two preceding; length, 3.4 mm. *bryanti* Cameron.

Thorax more transverse, one-third wider than long, widest behind anterior angles; antennæ with first two joints equal in length, 11th obconic, broader than the preceding; length, 2.75 mm...... .. ..*parvus* Cameron.

122. Thorax more transverse, one-third or more wider than long... .... 123.

Thorax slightly transverse...124.

123. Thorax about twice as wide as long; sides slightly narrowed posteriorly; antennæ a little shorter than head and thorax; elytra densely and strongly punctate; length, 3–3.6 mm.. . . . .*ceylanensis* Kraatz.

Thorax less transverse, about one-third wider than long, sides arcuate, narrower than elytra, widest at anterior third; 11th antennal joint a little longer but not thicker than preceding; length, 2.8 mm...... *insularis* Cameron.
124. Thorax with distinct medio-basal smooth carinulation, slightly transverse, strongly punctate; length, 4.1 mm.......................*indicus* Kraatz.
Thorax without distinct medio-basal carinulation; sparsely punctate.....125.
125. Thorax with sides strongly converging posteriorly, smaller, not more than two-thirds as wide as elytra; elytra longer than wide; length, 4.5 mm. (extended)..*hudsonicus* Casey.
Thorax with sides moderately converging posteriorly, larger, slightly narrower than elytra..126.
126. Eyes moderate; elytra less densely punctate than thorax; antennæ slightly shorter than head and thorax, last joint abruptly larger; length, 4.1 mm. *variabilis* Erichson.
Eyes large; last antennal joint not abruptly larger; length, 3.37–4.1 mm. *decussatus* Wollaston.
127. Head without distinct tempora...128
Head with distinct tempora..134.
128. Elytra shorter, not more than one-half longer than thorax..........129.
Elytra longer, about twice as long as thorax..............................131.
129. Thorax not narrower than elytra, one-third wider than long, with distinct medio-basal smooth carinulation; length, 3.5 mm...*brevipennis* Bernhauer.
Thorax distinctly narrower than elytra..130.
130. Thorax slightly narrower than elytra, with sides feebly arcuate and feebly narrowed posteriorly, disc coarsely punctate without distinct median smooth area; length, 5.1 mm........................*breviceps* Sharp.
Thorax much narrower than elytra, sides greatly narrowed posteriorly, disc moderately closely punctate and bi-impressed; 11th antennal joint scarcely thicker and but little longer than preceding; length, 4.5 mm. *fusciventris* Sharp.
131. Thorax strongly narrowed posteriorly...132.
Thorax not or but slightly narrowed posteriorly..............................133.
132. Thorax strongly transverse, much narrower than elytra, disc coarsely punctate, without medio-basal smooth area; elytra coarsely punctate basally, gradually more sparsely apically; 11th antennal joint broader than preceding and as long as preceding two; length, 2.7 mm........*fragilis* Sharp.
Thorax slightly transverse and only slightly narrower than elytra, coarsely and densely punctate; elytra "densely and rather finely punctate"; 11th antennal joint "quite short"; length, 4 mm.............*filum* Sharp.
133. Thorax not narrowed posteriorly, twice as wide as long, sides scarcely arcuate; elytra slightly wider than thorax; length, 3 mm.....*brevicollis* Sahlberg.
Thorax slightly narrowed posteriorly, moderately transverse, disc scarcely impressed with carinulation indistinct; elytra much wider than thorax, nearly twice as wide; length, 2.8–3 mm.........*continentalis* Bernhauer.
134. Thorax with more or less distinct medio-basal smooth carinulation........135.
Thorax without medio-basal carinulation...136.
135. Size larger, 4 mm.; thorax more strongly narrowed posteriorly. *difficilis* Cameron.

Size smaller, 2.5 mm.; thorax only slightly narrowed posteriorly. *malandanus* Bernhauer.

136. Size much larger, 6.5 mm.; form robust; thorax slightly narrower than elytra; antennæ with 11th joint longer and much thicker than preceding. *palmatus* Sharp.

Size much smaller, 2.5–3 mm.............. ....137.

137. Elytra distinctly wider than thorax, one-half wider; length, 2.8 mm. *amplipennis* Fall.

Elytra only slightly wider than thorax. . ...138.

138. Male—6th ventral abdominal segment not asymmetrically modified......139.

Male—6th ventral abdominal segment asymmetrically modified ... ...140.

139. Male—6th ventral abdominal segment deeply bi-incised, middle ligula broadly rounded; length, 2.8 mm....... .. ..*normalis* LeConte.

Male—6th ventral abdominal segment with two long, apically incurved lateral processes and a short, rounded, median lobe; length, 2.5 mm. *procerus*, new species.

140. Male—6th ventral abdominal segment bi-incised, the median ligula contorted and unsymmetrically curved, broadly truncate at apex. Female—the same segment broadly, deeply and angularly emarginate; length, 3 mm. *testaceus* Erichson.

Female—6th ventral abdominal segment with narrow, deep parallel-sided emargination or evenly and shallowly sinuate or truncate...........141.

141. Female—6th ventral abdominal segment with narrow, deep, parallel-sided emargination; male—6th ventral abdominal segment bi-incised, the median ligula longer and narrower, asymmetrically curved, concave and truncate at apex; length, 2.5 mm................ .*contortus* LeConte.

Female—6th ventral abdominal segment shallowly and broadly sinuate or truncate at apex.......................... .... .142.

142. Female—6th ventral abdominal segment sinuate at apex .. ..143.

Female—6th ventral abdominal segment truncate at apex............... .144.

143. Female—sinus of 6th ventral four or five times as wide as deep. Male—"with the ligula convex, smooth, long and parallel, its apex only moderately oblique from angle to angle but strongly arcuate sinistrally and thence straighter and more oblique to the angle at the right"; length, 3 mm. *luteus* Casey.

Female—sinus of 6th ventral seven or eight times as wide as deep. Male—ligula "flat, gradually and obtusely, subobliquely acuminate behind, short, broad basally and with a short acute longitudinal fold at apex on the left side"; length, 3 mm....... .. ..*fraternus* Casey.

144. Form not quite so slender (more slender than in *testaceus* Erichson). Female—6th ventral abdominal segment with a minute, median sinus, shallow and evenly curved; male undescribed; length, 3 mm..... *invidus* Casey.

Form more slender (thorax more transverse). Female—6th ventral abdominal segment more narrowed apically, apex rectilinearly truncate. Male—"ligula of the 6th ventral narrower than in *testaceus*, *luteus* and other similar species, and with the apex oblique in contrary sense or from the right anteriorly to the left, its surface concave and gradually more elevated at the right edge"; length, 3 mm . . . . . . *timidus* Casey.

RECORDS AND DESCRIPTIONS OF NEW SPECIES

Palaminus lengi, new species

Form slightly robust. Color piceo-testaceous, head and thorax more rufous, the abdomen darker with the fifth segment blackish basally, the elytra with suture and inflexed margins narrowly infuscate and the disc with an elongate fuscous spot behind the middle. Integuments strongly shining. Head slightly wider than the thorax, about one-half wider than long, the tempora distinct behind the eyes, the base strongly emarginate medially with the beading interrupted, the antennæ with the apical joints very elongate, the ultimate scarcely longer or wider than the penultimate, the punctures coarse, distinct and rather sparse. Thorax about one-third wider than long, widest at apical fourth, sides evenly arcuate and strongly convergent basally, basal angles not distinct, disc with distinct median carinulation, bi-impressed either side with four distinct series of punctures, the outer pair approximate basally, more sparse and coarse punctures laterally. Elytra about one-half wider and one-half longer than the thorax on the suture, the punctures moderately coarse and close, apex impunctate. Length, 3.75 mm.

FEMALE (?).—Apex of sixth ventral abdominal segment rectilinearly truncate.

Type: Adjuntas, Porto Rico, June 8–13, 1915.

Palaminus parvipennis, new species

Form slender; color rufo-testaceous, abdomen darker, integuments alutaceous, lustre dull. Head strongly transverse, twice as wide as long, wider than the thorax, the tempora distinct, the base widely and distinctly emarginate medially, punctuation rather coarse and sparse but indistinct; antennal joints rather short, the apical stout, longer and wider than the penultimate. Thorax two-fifths wider than long, widest at middle, sides arcuate, scarcely more convergent basally than apically, posterior angles not distinct, punctuation coarse, moderately close and evenly distributed, disc without median impunctate area, carinulation or impressions. Elytra rather small, one-third wider and less than one-half longer than the thorax, slightly wider posteriorly, one-fourth longer than wide, punctuation rather sparse fine and indistinct. Length, 3–3.5 mm.

MALE.—Sixth ventral abdominal segment with a strong median ligula which is asymmetrically curved to the left, broad at base and rather rapidly narrowed to an obtusely rounded apex, segmental margin slightly emarginate to the left.

FEMALE.—Sixth ventral abdominal segment with the apex very slightly emarginate.

Type and four paratypes· El Yunque, Porto Rico, February, 1921, 2000 ft. Allotype: Loiza, Porto Rico, February, 1913.

Palaminus bifidus, new species

Form slender; color rufo-testaceous, the abdomen darker; integuments alutaceous, lustre rather dull. Head strongly transverse, twice as wide as long, wider than the thorax, the tempora distinct, the base emarginate medially, punctuation coarse, sparse and rather indistinct, apical antennal joints missing in the type. Thorax one-third wider than long, widest near apical third, sides moderately arcuate and strongly narrowed to the base, basal angles completely rounded, punctuation coarse, modderately close, rather indistinct, regular without median impunctate area, carinulation or distinct impressions. Elytra one-third wider and one-third longer than thorax, wider posteriorly, one-fourth wider than long, punctuation rather coarse and close but indistinct, subrugulose. Length, 2.5 mm.

MALE.—Sixth ventral abdominal segment with a strang symmetrical median ligula which is rather rapidly narrowed to an acute apex, the apex being minutely but sharply bifid.

FEMALE.—Sixth ventral abdominal segment very slightly emarginate apically.

Type: El Yunque, Porto Rico, February, 1921, 2000 ft. Allotype and two paratypes: Aibonito, Porto Rico, June 1-3, 1915. Two paratypes: Adjuntas, Porto Rico, June 8-13, 1915.

In the allotype the two apical antennal joints are distinctly larger, the apical being longer and thicker than the penultimate.

Palaminus scitulus, new species

Form slender; color testaceous, abdomen darker; integuments alutaceous, lustre dull. Head strongly transverse, about twice as wide as long, wider than the thorax, the tempora indistinct, subobsolete, base broadly and distinctly emarginate, punctuation coarse, and sparse; antennæ with the apical joint rather short, longer and thicker than the penultimate. Thorax one-third wider than long, widest at apical fourth, the sides arcuate and distinctly more convergent basally than apically; the punctuation only moderately coarse and sparse, indistinct, no median impunctate area or carinulation, disc faintly bi-impressed. Elytra a little wider and one-fourth longer than the thorax, scarcely elongate, punctuation coarse, rather close and subrugulose. Length, 2.5 mm.

MALE.—Sixth ventral abdominal segment somewhat produced and arcuate medially.

FEMALE.—Sixth ventral abdominal segment broadly and feebly emarginate medially.

Type: Aibonito, Porto Rico, June 1-3, 1915. Allotype: Aibonito, Porto Rico, June 1-3, 1915.

Palaminus pusillus, new species

Form slender; color rufo-testaceous, abdomen darker; integuments alutaceous lustre dull. Head about twice as wide as long, wider than the thorax, the tempora indistinct, subobsolete, base broadly and distinctly emarginate, punctuation coarse, sparse, indistinct; apical antennal joints lacking. Thorax one-fifth wider than long, widest at apical fourth, sides feebly arcuate and rather strongly narrowed posteriorly, punctuation coarse, rather sparse and indistinct, no distinct median impunctate area, carinulation or impressions. Elytra one-third wider and one-half longer than the thorax, punctuation coarse and close but shallow and indistinct, subevenly distributed. Length, 2.75 mm.

Type: El Yunque, Porto Rico, February, 1921, 2000 ft.

The genitalia are missing.

Palaminus grandicollis, new species

Form slender; color rufo-testaceous, abdomen darker; integuments alutaceous, lustre dull. Head strongly transverse, about twice as wide as long, as wide as the thorax, the tempora distinct, the base widely and distinctly emarginate medially, the beading not interrupted, punctuation coarse and rather sparse; antennal joints rather short, the apical a little wider and longer than the penultimate. Thorax not quite one-half wider than long, widest at apical third, sides arcuate, not more convergent basally than apically, punctuation coarse, rather sparse and indistinct, without any impunctate median area or carinulation, very faintly bi-impressed. Elytra a little wider and scarcely more than a fourth longer than the thorax, a little longer than wide, rather coarsely, closely and somewhat rugulosely punctured. Length, 2.5–3. mm.

MALE.—Sixth ventral abdominal segment a little produced and arcuate medially.

FEMALE.—Sixth ventral abdominal segment slightly emarginate apically.

Type, allotype, and one paratype: Aibonito, Porto Rico, June 1–3, 1915. One paratype: Adjuntas, Porto Rico, June 8–13, 1915.

Palaminus dubius, new species

Form slender; color rufo-testaceous, abdomen darker; integuments strongly shining. Head about twice as wide as long, wider than the thorax, the tempora distinct, the base widely and distinctly emarginate medially, punctuation coarse, somewhat sparse and distinct; antennæ with the apical joints short, the apical scarcely longer but distinctly thicker than the penultimate. Thorax one-third wider than long, widest at apical fourth, sides arcuate, distinctly but not strongly narrowed posteriorly, punctuation coarse, moderately sparse and somewhat irregular, a rather distinct medio-basal carinulation with slight impressions either side. Elytra one-third wider and longer than the thorax, one-fourth longer than wide, punctuation coarse, rather close and evenly distributed, scarcely sparser or finer posteriorly, surface subrugulose. Length, 2.35 mm.

The sixth ventral abdominal segment is very slightly produced and rounded apically.

Type: Gourbeyre, Guadeloupe.

Palaminus procerus, new species

Form slender; color testaceous, abdomen darker; integuments strongly shining. Head about twice as wide as long, scarcely wider than the thorax, tempora distinct, the base broadly and distinctly emarginate medially, punctuation coarse, sparse and distinct; antennal joints rather short, somewhat shrunken. Thorax about one-fourth wider than long, widest just before the middle, sides rather feebly arcuate, but slightly more convergent basally than apically, punctuation coarse, somewhat sparse, distinct, without median smooth area or carinulation, scarcely impressed. Elytra a little wider and about one-third longer than the thorax, conjointly about one-third longer than wide, the punctuation much closer and more distinct on basal third, not very coarse, the surface subrugulose. Length, 2.5 mm.

MALE.—Sixth ventral abdominal segment with two long lateral processes incurved at tip, the arcuate emargination between them with a short median lobe, broadly rounded at apex.

Type: Aibonito, Porto Rico, June 1–3, 1915. Paratype: male, Aibonito, Porto Rico, June 1–3, 1915.

The paratype lacks head and thorax.

In addition to the species described as new the following are recognized in the material at hand.

Palaminus apterus Bernhauer

Gourbeyre, Guadeloupe, two specimens.

Palaminus insularis Cameron

Aibonito, Porto Rico, June 1–3, 1915, and Gourbeyre, Guadeloupe, two specimens.

CATALOGUE

THE SPECIES OF *Palaminus* DESCRIBED SINCE 1911

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parvus Cameron, 1918, Trans. Ent. Soc. Lond., p. 71..................Singapore.
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AMERICAN MUSEUM NOVITATES

Number 387
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
Nov. 27, 1929

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A NEW PALEOCENE UINTATHERE AND MOLAR EVOLUTION IN THE AMBLYPODA

BY GEORGE GAYLORD SIMPSON

In several earlier papers there has been mentioned the existence in the Clark Fork Formation of a uintathere earlier and more primitive than any previously known from America.[1] It is the purpose of the present paper to name and describe this form and to discuss briefly its bearing on conceptions of amblypod phylogeny and, particularly, molar evolution. The drawings are by John Germann.

PROBATHYOPSIS, new genus

DIAGNOSIS.—Upper teeth as in *Prodinoceras* so far as known, except that on P^2 the external and posterior borders are more nearly at right angles, the protocone less separate and united to the middle of the ectoloph by a single inconspicuous crest, unbasined, the metacone less distinct; that the cingula pass completely around the protocones on all the upper teeth; and that the hypocones are posterior and slightly external, rather than internal, to the protocones. The paraconid shelves of the lower molars more distinct than in *Bathyopsis*, and these teeth relatively longer, narrower, and higher. The posterior talonid crest less continuous than in *Bathyopsis*, but otherwise similar. The talonid of M_3 differing markedly in this respect from that of *Prodinoceras*. A small flange on the lower jaw, but this much less developed than in *Bathyopsis*.

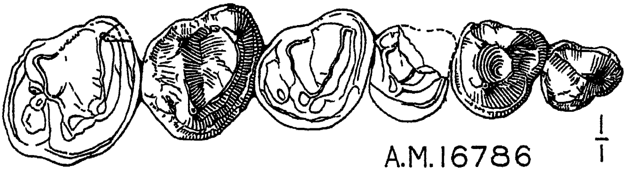

Fig. 1. *Probathyopsis præcursor*, new genus and species. Right upper cheek teeth, crown view. Shaded teeth from type, Amer. Mus. No. 16786, P^3 reversed from left side. Teeth in outline, from a topotype, Amer. Mus. No. 16984. Natural size.

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[1] Wood, H. E. 1923. 'The Problem of the *Uintatherium* Molars.' Bull. Amer. Mus. Nat. Hist., XLVIII, pp. 599–604 (see p. 601).
Matthew, W. D. 1928. 'The evolution of the mammals in the Eocene' Proc. Zool Soc. London, 1927, pp. 947–985 (see pp. 956, 969–970).
Matthew, W. D., Granger, W., and Simpson, G. G. 1929. 'Additions to the Fauna of the Gashato Formation of Mongolia.' Amer. Mus. Novitates, No. 376, pp. 1–12 (see p. 10).

Probathyopsis præcursor, new species

Type.—Amer. Mus. No. 16786, lower jaws with imperfect dentition, and associated upper teeth. Collected in 1913 by W. Stein.

Horizon and Locality.—Clark Fork Formation, Clark Fork Basin, Wyoming. The type is from the head of Big Sand Coulee. Other specimens, collected in 1911, 1912, and 1916 by American Museum expeditions under Walter Granger, include material from this locality and also from opposite the mouth of Little Rocky Creek, from the base of a bluff five miles northeast of Ralston, and from three miles east of the mouth of Pat O'Hara Creek. Some of this material may be from the Sand Coulee horizon.

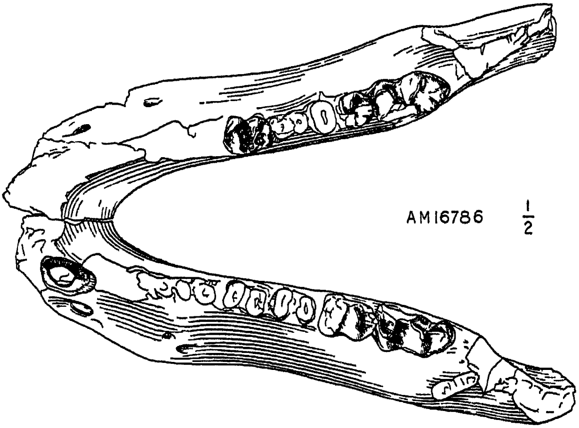

Fig. 2. *Probathyopsis præcursor*, new genus and species. Lower jaws, crown view. Type, Amer. Mus. No. 16786. One half natural size.

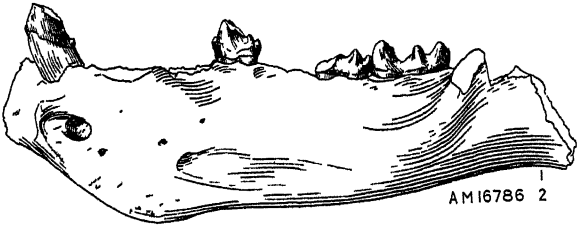

Fig. 3. *Probathyopsis præcursor*, new genus and species. Left lower jaw, external view. P_4 reversed from right side. Type, Amer. Mus. No. 16786. One half natural size.

Diagnosis.—With the characters of the genus. Length of M_3, 21.7 mm.

The dentitions of the three earliest known uintatheres, *Probathyopsis*, *Prodinoceras*, and *Bathyopsis*, are all incompletely known, so that further discoveries will expand the distinctions given in the above generic diagnosis. *Probathyopsis* and *Prodinoceras*,[1] the latter from the Gashato Formation of Mongolia, are distinct but very closely related genera. Although a more complete basis for comparison may somewhat modify this view, the known distinctive characters of *Probathyopsis* tend toward a somewhat closer resemblance to the later American genera. The stage of evolution is almost the same in the two Paleocene forms, but *Prodinoceras* may prove to be very slightly more advanced. They may be tentatively considered as showing incipient divergence from an immediate common ancestry, *Probathyopsis* leading to some or all of the later American uintatheres, *Prodinoceras* possibly to an otherwise unknown Asiatic phylum.

The known characters distinguishing *Probathyopsis* from *Bathyopsis* all indicate the more primitive nature of the former, and nothing is known which would exclude the possibility of a directly ancestral relationship.

Both Matthew and Wood considered the present genus, which they mentioned but did not describe, as increasing the probability that the Coryphodontidæ and Uintatheriidæ are parallel phyla, quite distinct from each other. The question of the relationship between these two groups is too complex for full discussion here, but the bearing of *Probathyopsis* and *Prodinoceras* on this problem must be mentioned.

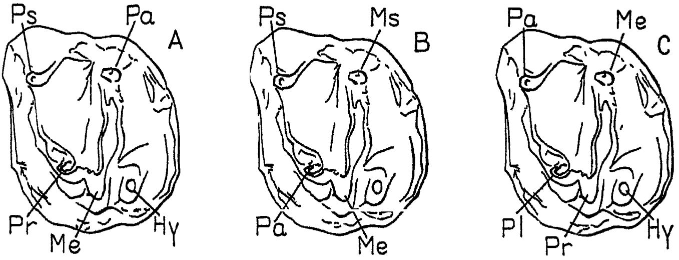

Fig. 4. Theories of cusp homologies in *Uintatherium* upper molar. A, Osborn. B, Matthew, rejected alternative. C, Wood, Matthew, Simpson.

Osborn[2] in 1898 elaborated the conception of the Pantolambdidæ, Coryphodontidæ, and Uintatheriidæ as successive families forming a structurally ancestral series. According to his view, the *Coryphodon* upper molar arose from one like *Pantolambda* by the rotation of the ectoloph and reduction of the paracone, and from this the *Uintatherium* molar was derived by further rotation of the ectoloph, so that the metacone became approximated to the protocone. The premolars of *Pantolambda* and *Coryphodon* are closely similar and have homologous parts. Those of *Uintatherium*, according to Osborn's theory of 1898, must have arisen by the complete suppression of the internal heel, and hence have had a very different history from the molars, which they closely resemble.

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[1] See Matthew, Granger, and Simpson, *op. cit.*, 1929.

[2] Osborn, H. F. 1898. 'Evolution of the Amblypoda. Part I. Taligrada and Pantodonta.' Bull. Amer. Mus. Nat. Hist., X, pp. 169–218.

Wood (*op. cit.*, 1923) has raised serious objections to this view. He holds that the *Coryphodon* and *Uintatherium* upper molar patterns are not formed by homologous elements, but that in the latter Osborn's "metacone" is the protocone, his "protocone" the protoconule, his "paracone" the metacone, and his "parastyle" the paracone; that is, that the *Uintatherium* molar has a normal trigon modified by an unusual type of lophiodonty.

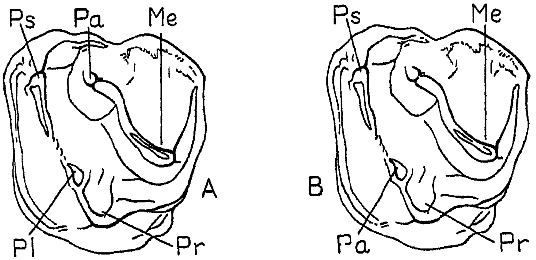

Fig. 5. Theories of cusp homologies in *Coryphodon* upper molar. A, Osborn, Simpson. B, Matthew.

Matthew (*op. cit.*, 1928) advanced, only to reject it, the alternative hypothesis that in *Uintatherium* Osborn's "protocone" and "metacone" are the paracone and metacone, respectively, his "parastyle" and "paracone" the parastyle and metastyle, and that the protocone is lacking, but he concluded that the evidence of *Prodinoceras* (including the genus now named *Probathyopsis*) confirmed Wood's view. For *Coryphodon*, however, he advanced a new theory, namely, that the upper molars of this genus "apparently . . . are derived from something of the *Pantolambda* type, by uniting the anterior limbs of the paracone and protocone crescents into a single crest, and loss of their posterior limbs, the metacone crescent remaining little changed or losing its anterior[1] limb."

Prodinoceras and *Probathyopsis* seem to offer definitive evidence regarding the origin of the uintathere molar and to establish Wood's view beyond much question, as recognized by Matthew. The external ends of the two lophs are clearly the paracone and metacone, and the chief internal cusp is clearly the protocone. The so-called "protoloph" connects the paracone and protoconule, the "metaloph" ("ectoloph" of Osborn in 1898) unites the metacone and protocone. They are not homologous with any of the three perissodactyl lophs. There is an ectoloph in the Paleocene genera, particularly in the premolars, but in the later genera the deepening of the notch between the paracone and metacone causes the disappearance of the ectoloph as such.

---

[1] A *lapsus calami* for "posterior"?

This view has the added recommendation that it considers the posterior premolars and anterior molars, almost identical in form, save for the presence of a hypocone in the latter, as composed of homologous parts instead of assigning to them widely different histories.

Careful restudy of the *Pantolambda* and *Coryphodon* molars seems to confirm Osborn's views as to cusp homologies in the latter, although not his mechanical interpretation of their origin. In *Pantolambda* the paracone and metacone are equal, strongly crescentic, their apices median. The last deciduous molar of *Coryphodon* gives a valuable clue to the origin of the pattern of its true molars. Its parts are clearly

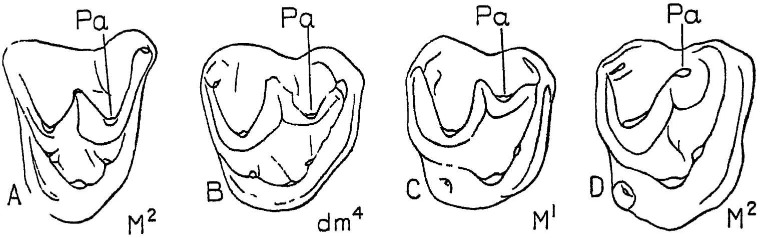

Fig. 6. Structural evolution of coryphodont upper molar. A, *Pantolambda*, M^2. B, *Coryphodon*, dm^4. C, *Coryphodon*, M^1. D, *Coryphodon*, M^2. Not to scale.

homologous with those of *Pantolambda*, but the paracone is reduced in size, less crescentic, its apex relatively more external, and anterointernal to it, below its own anterior crest, the anterior crest of the protocone has unusual strength and distinction. M^1 of the less advanced coryphodonts is intermediate between this and the more aberrant M^{2-3}. The paracone apex is relatively still more external, but this cusp retains traces of its former crescentic nature; the anterior wing of the protocone crescent is still stronger and tends to sever connection with the paracone, and the posterior wing of the metacone is somewhat weaker. In its next stage, the paracone is styloid.

The posterior crest of the *Coryphodon* molar cannot be called the ectoloph, for it represents only the anterior wing of the metacone crescent, and it cannot be said to have rotated, for its relations are exactly as in *Pantolambda.* Nor is the anterior loph a typical protoloph, for it is only the anterior wing of the protocone crescent and in its final development has no connection with the paracone.

The triangular upper premolars of the coryphodonts and those of the uintatheres are superficially similar, but the late Paleocene forms seem to show that the main triangles are not composed of homologous parts in the two groups. In *Coryphodon,* aside from the internal heel, the triangle is composed of the paracone-metacone internally and stylar cusps externally—it is an ectotrigon, homologous with the outer part of the molars. In *Uintatherium* the triangle is composed of the protocone internally and of the paracone and metacone externally—it is an endotrigon, homologous with the inner part of the molars. Here, as in the molars, the resemblance of *Coryphodon,* such as it is, is rather with the most specialized uintatheres than with the primitive *Probathyopsis* or *Prodinoceras.*

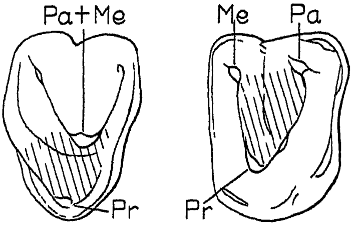

Fig. 7. Homologies of *Coryphodon* (left) and *Uintatherium* (right) upper premolars. Homologous trigons shaded. Not to scale.

The lower molars, while less strikingly different, also have separate histories in the coryphodont and uintathere phyla. In both, the anterior loph is a true metalophid, formed by the protoconid and metaconid, but this is a tendency so nearly universal in ungulates as to be no indication of affinity.[1] The heel is distinctive. In *Coryphodon* the talonid loph runs anteroexternal-posterointernally and is a true hypolophid, joining the hypoconid and entoconid. In *Uintatherium,* on the contrary, the main heel loph runs posteroexternal-anterointernally, and, as shown in *Probathyopsis* where it is incompletely formed, unites the hypoconulid and entoconid. There is also a secondary crest, nearly parallel to this, which runs from the hypoconid toward the metastylid. The latter cusp, absent in *Coryphodon*, is already well developed in *Probathyopsis*.

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[1] It is, in fact, a fundamental character of the Theria, which has been lost where it does not occur, and emphasized in the present, and many other, groups.

Both coryphodonts and uintatheres thus represent early attempts at the formation of lophiodont molars, but each has formed these in its own way, converging toward a common adaptive type. The lophiodont perissodactyls represent a third and more successful acquisition of the lophiodont habitus, and they, again, form the lophs in a way peculiar to themselves. The lophs of these three groups are neither homologous nor homoplastic.

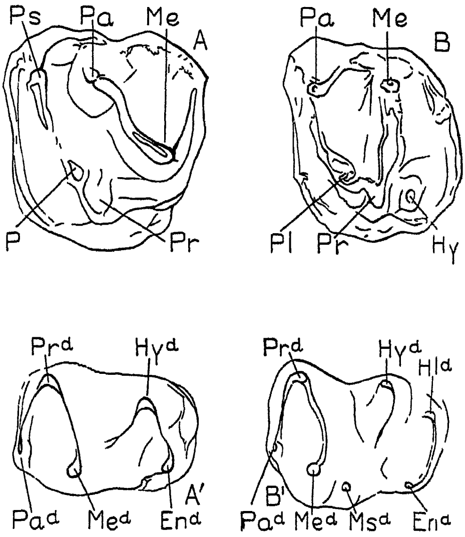

Fig. 8. Independent loph formation in coryphodonts and uintatheres. A, *Coryphodon* upper molar. A′, *Coryphodon* lower molar. B, *Uintatherium* upper molar. B′, *Uintatherium* lower molar. Not to scale.

The coryphodonts, uintatheres, and perissodactyls seem to me to afford a striking example of the view that when different phyla acquire similar habiti some time after their separation from a common ancestry, there is no inherent tendency for these modifications to arise in the same way in the independent lines. The homologous parts are those alone which were already present in the common ancestry—in ungulate upper molars generally, only the three primary cusps and possibly the conules. There may be a tendency (to call it inherent would involve a personal definition of the word) to form lophs, for instance, but there appears to be no fixed tendency for these to form in the same way or from the same parts in independent groups, except when these phyla had identical or closely similar molars at or after the inception of lophiodonty. Animals which fulfil this last condition are usually closely related, and an apparent inherent tendency to form lophs in the same way in related phyla is consequently often seen, but I conceive the conditioning factor to be not the metaphysical one of germinal predestination but the physical one of mechanical resemblance.

If the above conclusions regarding molar evolution in the coryphodonts and uintatheres are correct, it is necessary to suppose that when true lophiodonty was first appearing in the two groups the upper molars of their ancestors, although tritubercular in both groups, were of different mechanical types. For the coryphodonts one would infer an ancestry with strongly selenodont molars, the paracone and metacone apices median. For the uintatheres, projecting backward the *Eobasileus-Probathyopsis* line, one would infer an ancestry with the paracone and metacone non-crescentic, their bases connate, their apices external, the protocone subcrescentic but its crests running to the bases of the paracone and metacone, not anterior and posterior to them.

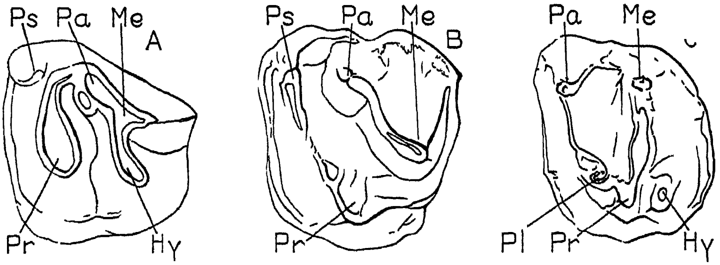

Fig. 9. Independent loph formation in three distantly related ungulate phyla. A, Perissodactyla, *Hyrachyus*. B, Pantodonta, *Coryphodon*. C, Dinocerata, *Uintatherium*. Not to scale.

So far as the dentition is concerned, *Pantolambda* is an almost ideal ancestral type for *Coryphodon*, and it has long been recognized that they are related. Direct ancestry is impossible, for while it would form a suitable basis for the coryphodont dental specialization, *Pantolambda* does not show any actual beginning of this advance, and, judging from the rate of evolution of other phyla, the time between the Torrejon and Clark Fork was much too short to accomplish this degree of evolution.

Probathyopsis is almost as primitive with respect to the upper Eocene uintatheres as is *Pantolambda* with respect to *Coryphodon,* and the relationship is more directly ancestral than in the latter case. *Pantolambda* cannot have been ancestral, either directly or structurally, to *Probathyopsis.* Pantolambdid relationship to the uintatheres requires reëxamination, but the evidence of the dentition of the Paleocene uintatheres suggests that any relationship must be collateral and rather distant.

The uintatheres and coryphodonts are not successive but contemporaneous. Both appear in America in the Clark Fork. Coryphodonts here died out by the Middle Eocene, but they apparently survived in Mongolia into the later part of the period. The known distribution of the principal genera involved in this discussion is as follows:

	Paleocene			Eocene		
	Lower	Middle	Upper	Lower	Middle	Upper
Pantolambdidæ						
Pantolambda		N.A.				
Titanoides			N.A.			
Coryphodontidæ						
Coryphodon			N.A.	N.A.		
Eudinoceras						Asia
Uintatheriidæ						
Prodinoceras			Asia			
Probathyopsis			N.A.			
Bathyopsis				N.A.		
Uintatherium					N.A.	
Eobasileus						N.A.

AMERICAN MUSEUM NOVITATES

Number 388
Published by
The American Museum of Natural History
New York City
Dec. 4, 1929

59.57, 96 A

OBSERVATIONS ON LEAF-CUTTING ANTS

By Frank E. Lutz

It is not often that one has so good a "set up" for certain observations as that provided by a colony of *Atta cephalotes polita*[1] near the laboratory of the Institute for Research in Tropical America in the Panama Canal Zone. Accordingly, I dropped the work which I had intended to do during a short stay there and concentrated my attention on these ants.

The colony was a small one, as such colonies go, and had at that time only one trail along which they were bringing pieces of leaves. Therefore, watching this trail gave one a fairly comprehensive idea of the external activities of the colony. Furthermore, the entire trail between the nest and the trees whose leaves were being cut, a distance of only about 15 meters, was along a net-work of lianas, so that the ants could be seen easily. And, finally, this liana trail was so arranged that one could select reasonably straight 50-centimeter stretches at almost any steepness of grade that one wished. This latter feature made it possible to study the relation between grade and speed of walking under natural conditions. Unfortunately, my stay at the laboratory was such a short one that I had time to study carefully only three grades: a steep down-grade, a steep up-grade, and a relatively level stretch.

Since temperature has so marked an effect on the activities of insects—a thing that has not been well investigated for tropical species and really what led me to go to Panama—the constancy of temperature near the ground in a tropical forest greatly simplified matters. During the hours in which these ants were carrying leaves the temperature was never below 26° nor above 28° C. Likewise, the humidity was very constant at that time, near the end of the dry season (the latter part of March). Light was the most variable of the important environmental factors if, as I believe, it is important.

Many accounts[2] of leaf-cutting ants give the reader an impression that these ants work chiefly at night. This may be true of some species and in other cases there seems to be a variation depending on several factors. Belt said: "In dry and hot weather, when the leaves would get dried up before they could be conveyed to the nest, the ants, when in exposed situations, do not go out at all during the hot hours, but bring in their leafy burdens in the cool of the day and during the night." The colony reported upon here had its nest and its entire trail in the comparative shade of the forest. I am not in a position to know how it may be with this nest at other seasons, but certainly during the period covered by these observations there was no activity outside of the nest before sunrise or after sunset even during the time of full moon. In fact, the setting out from the nest to work in the morning and the quitting work in the evening were among the most interesting things noticed on the liana trail.

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[1] Identifications kindly made by Professor Wheeler

[2] Including the ancient Guatemalan myth quoted by Wheeler in his valuable paper on 'Fungus-growing Ants of North America' (1907, Bull Amer. Mus Nat Hist , XXIII, pp 669–807)

In the early morning a few workers could be seen congregating in the outer gallery of the nest near the exit. As they moved back and forth they oradually came nearer the outer opening. Then several would wander outside, only to go back again. A little later one or two of these would retrace their steps. Then, as though at a signal, a number would go out at once, some of them possibly continuing to the tree but others, like the storied plumber returning to the shop for a forgotten tool, would go back. What is the signal that sends this first band of workers out to their tree? Doubtless "stimulus" would be a more technical term than "signal," but I confess that it seems cold and not descriptive of what I saw.

When returning individuals of the first wave reached the nest with cut leaves a second and larger wave of ants would leave and these seemed to go along the trail as though they were decidedly interested in getting there, not vacillating so much as the first group. To describe this I would be more willing to use the word "stimulus," for the bringing in of pieces of leaves seemed to arouse the nest to real activity.

To use another simile from human affairs, one might say that the first workers to start were like children going to school on a warm spring day, playing as they go and running this way and that. Then the bell rings and they more or less quickly settle down to the affairs of the day. Putting it in a statistical way, the following records of ants passing a point about three feet from the nest (and, so, beyond the zone of apparently aimless wanderings) will make the description more definite. Ants going back to the nest without a burden (piece of leaf) will be referred to as "unladen."

March 20.—There had been a rain during the night and the morning was cloudy. At 9:10 ants were taking out dirt but the leaf-carrying squad was not at the nest-opening. At 9:25 ants were gathering in the nest-gallery about two inches from the surface. At 9:55 the first carrier left the nest but went back at once. The gallery near the exit was rather crowded. At 10:03 a carrier went to the liana (the trail to their tree) about twenty inches from the nest but returned and almost immediately another went out and along the liana until at about thirty inches from the nest it was caught and carried off by a larger ant (*Paraponera clavata*), which had been standing there poised and motionless, facing the nest, for twenty minutes or so. Then something happened and work started suddenly, for between 10:08 and 10:10 forty-five ants poured out of the nest and along the liana trail, only two going back. In the next five minutes 64 went out and one returned. Between 10:15 and 10:20 only 24 went out and 15 returned unladen, not having gone as far as their tree; and in the next five minutes only 12 went out but 21 returned unladen. The first wave of carriers was apparently over but the sun broke through the clouds and, whether that had anything to do with it or not, from 10:30 to 10:35 there were 59 outgoing ants and only three going back unladen. In the following three five-minute periods there were 25 outgoing and 10 returning unladen; 158 (including a big "soldier") outgoing and 12 returning unladen; and 43 outgoing and 12 returning unladen. Then it became cloudy again and in the following successive five-minute intervals the ratios between outgoing ants and those returning unladen were: 4 to 19; 1 to 41; 14 to 44; 32 to 32; and 24 to 22. It seemed as though the cloudiness was driving the ants back. Between 11:15 and 11:20 there were 12 outgoing but among the 57 incoming ants one had a piece of leaf; and between 11:25 and 11:30, while 25 went out and 26 returned, two of the latter had burdens. Then successive intervals gave the counts shown in Table I.

TABLE I

Time	Outgoing	Ingoing	
		Unladen	Laden
11:30–11:35	79	9	7
11:35–11:40	138	4	7
11:40–11:45	75	11	19
11:45–11:50	97	7	22
11:50–11:55	60	5	26

The day's work was now under way.

March 21.—Only a light haze. Preliminaries much as yesterday. No ants went down the trail before 9:00, but then they started as is shown in Table II, an hour earlier than yesterday.

TABLE II

Time	Outgoing	Ingoing	
		Unladen	Laden
9:00– 9:05	28	1	
9:05– 9:10	69	7	
9:10– 9:15	34	11	
9:15– 9:20	13	26	
9:20– 9:25	34	13	
9:25– 9:30	21	32	
9:30– 9:35	11	25	1
9:35– 9:40	126	22	
9:40– 9:45	64	8	1
9:45– 9:50	33	24	2
9:50– 9:55	21	13	3
9:55–10:00	22	68	4
10:00–10:05	2	16	9
10:05–10:10	9	8	14
10:10–10:15	38	6	21
10:15–10:20	56	20	20

The suddenness with which work starts as well as what seems to be the stimulus of the first leaves to be brought in is illustrated by this apparently typical day.

No detailed accounts such as these were made the next two days and on March 24, the sun having risen in a nearly cloudless sky, the ants were already on the trail at 8:10, when I arrived. However, Table III illustrates the apparent effect of bringing in the first pieces of fresh leaves, as well as the greater activity on a bright day. (Note that this table does not include the first wave of carriers starting out from the nest.)

TABLE III

Time	Outgoing	Ingoing	
		Unladen	Laden
8:15 8:20	8	4	
8:20 8:25	5	6	
8:25- 8:30	13	4	
8:30- 8:35	49	9	2
8:35 8:40	189	10	9
8:40- 8:45	177	14	17
8:45- 8:50	131	12	20
8:50- 8:55	147	15	36
8:55- 9:00	47	15	26
9:00- 9:05	35	11	18
9:05- 9:10	61	17	37
9:10- 9.15	81	40	45

Other days had indicated the probable connection between the strength of the sunlight and the hour at which these ants started to work. Unfortunately, I had no instrument that would measure the light accurately enough to determine satisfactorily the amount of such a correlation, and future students should not forget that ultra-violet is probably of great importance.[1] However, during the evening of March 24, I made a canopy of black focusing cloth over the nest, arranging it so that it was at least six inches above any surface on which the ants would walk the next day. Sunrise of March 25 was unusually bright and there were practically no clouds until late afternoon, but not an ant left the shaded nest until 8:55, when a few of the smallest workers that do not seem to be of much value as carriers ventured forth. By 9:00, however, some of the regular carriers had left the edge of the shade and reached the bright sun and then the egress began in earnest, as is shown by the following counts of outgoing ants in the successive five-minute intervals of the next hour: 18, 76, 32, 75, 22, 24, 11 (removed the canopy; carriers with fresh leaves were coming back), 92, 83, 60, 56, and 123.

March 26 was another bright day and when I arrived at 8:00 A.M. the ants were already bringing in great quantities of leaves. The next day, also very bright, I arrived at 7:10 and found that the ants were already starting out.

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[1] See Lutz, 1924, Ann. N. Y. Acad Sci, XXIX, pp. 181–283.

There seems little room for doubt that light is a controlling factor, but it may act in conjunction with a physiological rhythm and, of course, we have as yet no measure of the amount of light which is necessary to start things going.

Deferring for a bit of discussion of the other points, Table IV, giving data for the partly cloudy afternoon of March 19, is presented as fairly typical of the quitting of outside work for the day. The count was made at a place on the trail about thirty feet from the nest.

TABLE IV

Time	Outgoing	Ingoing	
		Unladen	Laden
3:47– 3:52	6	13	16
3:56– 4:01	9	13	23
4:02– 4:07	6	15	22
4:09– 4:14	3	21	13
4:15– 4:20	1	15	20
4:21– 4:26	4	13	12
4:27– 4:32	3	14	20
4:33– 4:38		8	14
4:39– 4:44		4	9
4:45– 4:50		1	2
4:51– 4:56		1	6
4:57– 5:02		1	
5:03– 5:08			

By taking the algebraic sums of the numbers of outgoing and in coming ants one can determine the number of ants that were out on the trail at any time. For example, at noon of March 20 there were about 580 ants of this colony either going out, cutting leaves, or coming in.

Knowing how many leaves or pieces of leaves are carried to the nest in a day seemed to be of interest. Instead of spending a whole day to count them, I made a total of 57 five-minute counts at different times of several days, these counts being made after work had gotten well under way in the morning and before it had begun to slacken in the afternoon. The number of burdens passing a given point in any observed five minutes between these limits ranged from 12 to 69, the average being 24.9. Saying that the average rate is five per minute, the number of burdens in an average day of about eight hours work would be about 2400 pieces. Certainly 3000 pieces would seem to be a big day's work for this nest.

We have seen that there were 580 ants outside the nest at noon of March 20. Presumably, each was a potential carrier, although many came back to the nest unladen. Also, an unknown number of carriers were inside the nest at that time. If we estimate that the total number of carriers was only 600, it would mean that these workers do not average more than five pieces of leaf each per day, and it is quite probable that the average is less than four.

Now, the ants carrying leaves take, on the average, about 36 seconds to go a meter if they travel right along. Unladen ants can go even faster. The trip from nest to tree and back again was about 30 meters. An ant should make this, on the average, in 17 minutes. If we allow it five minutes to cut its piece out of a leaf, another five minutes to put it away in the nest, and three minutes for other purposes such as cleaning its antennæ, an ant might be expected to make a round trip in half an hour or at least sixteen, instead of four of five, such trips in an eight-hour day. If we wish to know whether any come up to this expectation it will be necessary to mark and watch individual ants and, furthermore, we do not know how much time the carriers give to gardening mushrooms and feeding larvæ, incidentally getting fed themselves, but a "sluggard" who is disposed to argue might get considerable satisfaction in going to these ants.

Part of the difference between possible and actual work done is due to unladen ants interfering with laden ones. The speed of a meter in 36 seconds noted above was the average of about 300 observations of carriers whose progress was not interrupted on the timed stretch. Frequently, however, an incoming laden carrier is stopped momentarily by an outgoing sister who apparently is interested in what is being carried. To see how much this visiting during working hours cost the colony, 300 observations were made on all carriers, including those that were stopped a bit by outgoing ants, and it was found that the average time taken to go a meter was about 40 seconds. This is an average delay of about four seconds per meter or, since the outgoing ant stopped as long as she delayed the incoming one, 120 seconds for the round trip of 30 meters. If there are 3000 round trips per day this is a loss of 100 ant-hours per day. It may be necessary, but an efficiency expert might object.

That part of the trail which in my notes is called No. 6 was 41 feet from the nest and was a 93 per cent down-grade to the incoming laden ants. No. 5 was 33 feet from the nest and practically level, having a grade of only 3.9 per cent. No. 3 in my notes was ten feet from the nest and had a 76 per cent grade up which the laden ants must climb before descending a grade nearly as steep to their nest on the side of the hill. Uninterrupted ants covered a 50-centimeter stretch down the steep grade of No. 6 in average time of 17.6 seconds. They did 50 centimeters on the practically level No. 5 in an average time of only 15.7 seconds but it took them an average of 22.2 seconds on the steep up-grade of No. 3. Clearly, it is not as easy for these ants to carry burdens down the steep No. 6 as it is on the level, and it is still more difficult to carry up the steep No. 3. In fact, one ant was nearly a minute struggling fifty centimeters up the latter slope. This is the sort of thing that we might expect and the reason for mentioning it here is that the average time on this slope does not seem to have been increased by interruptions, for the average when I timed each of a hundred ants that came along was also 22.2 seconds. On the next hardest slope, the steep down-grade of No. 6, there was a 5.7 per cent delay, the average time of a hundred carriers being 18.6 seconds. But on the nearly level there was a 16.6 per cent delay, the average time being 18 3 instead of 15.7 seconds to go fifty centimeters. Just what this means is not clear. Possibly it is that when the ants are on difficult going they are not so likely to stop to visit as elsewhere. It does not do to "humanize" insects but, although trained in a mechanistic school, the more I have studied insects—possibly it is the older I get—the less inclined I have become to think of them as purely tropism-ruled, instinct-bound machines. Even so, the following observations rather surprised me.

Occasionally a carrier would get into trouble with its burden because the burden catches on something, the wind blows it off balance, or for some other reason. At such times both outgoing ants and those that are returning to the nest unladen gather round and pull the leaf this way and that. In the mixup the original carrier sometimes loses its piece of leaf entirely, one of the others carrying it off. Under these circumstances the original ant, having been on its way to the nest, would have been expected on the chain-instinct theory to continue going there, especially as it is quite common for these ants to return unladen; but things seemed to happen otherwise. The ant that had been relieved of its burden usually returned to the tree and the other ant carried the burden to the nest.

In order to get enough observations to be fairly certain of this point, I robbed twenty carriers, pulling the leaf away with fine forceps in as natural a fashion as possible. Usually the robbed ant would run about a bit as though looking for what it had lost and would spend a few seconds cleaning itself before setting out in earnest. Two of the twenty went on to the nest unladen but the other eighteen started back for the tree. One of these latter stopped an ingoing carrier and tried to take its burden but, failing, continued on its way. Of course, we can say that it is the presence of a burden that stimulates the carrier to go toward the nest and when this is lost it goes in the other direction, but then we must look for the stimulus that sends other ants from the tree to the nest unladen. To me it seems easier to believe that these creatures think.

The workers of this species are of several sizes, including small ones called subminims. After watching affairs on the liana trail for several hours I called them "bad little boys," but the sex of that is wrong, and after more watching I called them "just kids" that will never grow up. They are among the first out in the morning and among the last in at night, lingering around the entrance to the nest, but they seem to do little that is very useful. When a carrier is in trouble with its burden these subminims, if anywhere near, rush in and pull with the rest. In such a case the piece of leaf when finally balanced over a carrier's back will almost certainly have at least one of these subminims resting calmly on it and riding back toward the nest. However, these subminims do not always wait for trouble but often on their own initiative stop an incoming carrier and get on its leaf for a ride. Sometimes, when another carrier's leaf touches the one a rider is on, the rider will change conveyances and continue its journey on the other leaf. When reaching the steep up-grade of No. 3 about ten feet from the nest the riders often got off. I imagine that this action was not out of consideration for their struggling sister but either because progess was not sufficiently steady or because the subminims seemed rarely to ride all the way into the nest at any rate.

In order to determine more easily the proportion of leaves having riders, I hung a small mirror a short distance from the liana and on the side opposite me. I could then see both sides of an incoming leaf at once. Observations on more than thirteen hundred leaves at different times of the day and on different parts of the trail showed that subminims were hitch-hiking on five per cent of them. On stretch No. 5, thirty-three feet from the nest, they were riding on only about 1.3 per cent of the leaves but on No. 3, the steep up-grade ten feet from the nest, they were on 8.1 per cent of the leaves and then, as was said before, some got off so that on No. 1, three feet from the nest, they were on only 4.8 per cent of the leaves that passed. Since they weigh so little (about 1 mg.), their riding probably does the colony little harm and they seem to enjoy it greatly.

In discussing the carrying of burdens by these ants it should be remembered that they lift the pieces of leaf and actually carry, not drag, them. The relation between the weights[1] of ants and the weights[1] of the burdens they were carrying is shown in Table V and Figure 1. Small ants can not carry excessively large burdens, possibly partly because of the difficulty in balancing a large piece of leaf. The maximum (relative to the size of the ant) load observed was ten times the weight of its carrier. This is the instance noted in the table in the class A, 2.75, B, 30.25 and the ant was making an average speed of 1.56 cm. per second up the 76 per cent grade.

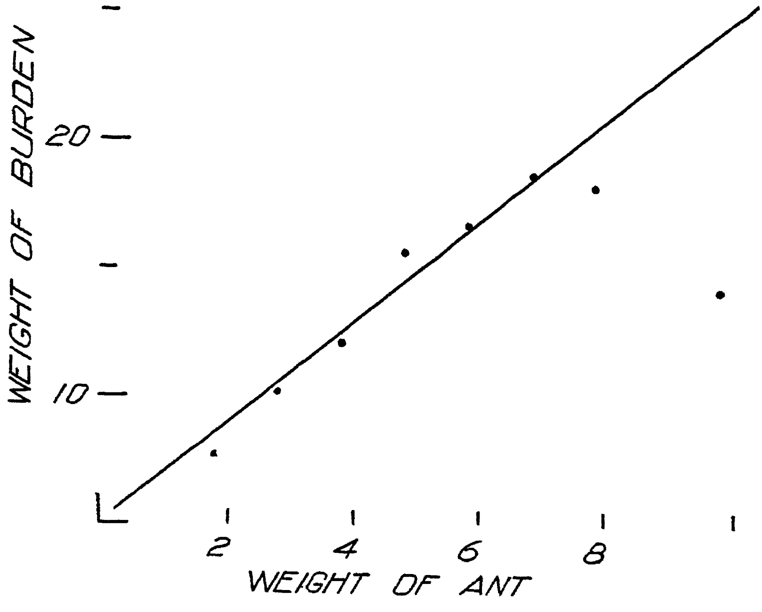

Fig. 1.—The relation between average weights of individual *Atta cephalotes* and the average weights of the burden carried.

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[1] These weights are those of specimens preserved in 75 per cent alcohol. The differences between them and "living weights" are less than the units of measuring and these, in turn, are less than the unit of grouping. Furthermore, it is a question of relative rather than of superexact absolute weights.

TABLE V

Weight of Ant

Weight of Burden	1 75	2 75	3 75	4 75	5 75	6 75	7 75	8 75	9 75	10 75	11 75	12 75	
2 25	1	8	5										14
6 25	4	22	18	8	4	2	1					1	60
10 25	2	29	28	16	13	4	2		2				96
14 25	1	14	22	17	15	1	2	1	1				74
18 25		8	8	12	4	5	1						38
22 25		1	5	7	7	6		1	1				28
26 25		1	4	4	5		3						17
30 25		1		1	4	2	1						9
34 25				3	1								4
38 25						1		1					2
	8	84	90	68	53	21	10	3	4			1	342

The fact that there is a correlation between the size of an ant and the weight of its burden does not, however, prove that there is a "choice" on the part of the ant. Still less does it prove that they deliberately cut a piece fitted to their strength. It merely means that if they try to start with an oversized piece—and I have often seen them do it—they do not get far with it and, so, do not get into the line of march. On the other hand, large ants more often than not carry burdens which seem unduly small. As a matter of fact, the average load, as observed, for the ants of this colony was roughly five milligrams more than twice the weight of the carrier. This is the formula of the straight line shown in Figure 1.

As would be expected, the data show at a glance that, in general, the greater the ratio of the weight of burden (B) to the size of the carrying ant as measured by its weight (A) the less the speed (S) expressed in centimeters per second. On the 76 per cent upgrade this correlation is —0.747±0.029; on the 4 per cent upgrade it is—0.746±0.027; and on the 93 per cent downgrade it is—0.634±0.038. The equality of this correlation coefficient on the steep up-grade and on the nearly horizontal seems somewhat more surprising than the lessened correlation between B/A and S on the steep downgrade. One might have expected that the relative burden would have affected the speed less on the practically level stretch than on the steep upgrade. A possible explanation is that some other factor than weight is involved. Such a factor may be the difficulty of balancing a large piece of leaf.

TABLE VI

Speed on a +4 Per Cent Grade

Weight of Burden/Weight of Ant	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25	5.75	6.25	
0.5						3	1	1	1			6
1.5					3	8	7	6	2	1	1	28
2.5				3	5	4	8	3				23
3.5			2	10	12	3	1	1				29
4.5		1	4	7	2	1	2					17
5.5		2	7	4								13
6.5	2											2
7.5			1		2							3
8.5	1											1
	3	3	14	24	24	19	19	11	3	1	1	122

TABLE VII

Speed on a +76 Per Cent Grade

Weight of Burden/Weight of Ant	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	
0.5					1		1			2
1.5					3	9	4		1	17
2.5			1	8	12	4	1			26
3.5			5	16	6	1				28
4.5		1	6	4	2	1				14
5.5		4	4		1					9
6.5	1		2	1						4
7.5		2								2
8.5										
9.5										
10.5			1							1
	1	7	19	29	25	15	6		1	103

TABLE VIII

Speed on a —93 Per Cent Grade

Weight of Burden/Weight of Ant	1.75	2.25	2.57	3.25	3.75	4.25	4.75	5.25	
0.5					1			1	2
1.5			2	3	8	1	1		15
2.5		2	10	13	9	4	1		39
3.5	3	4	12	5	3		1		28
4.5	3	5	4	6	1				19
5.5	3	3	2						8
6.5		2	1						3
7.5	1								1
	10	16	31	27	22	5	3	1	115

It is a favorite indoor sport of some people, after noting the ratio between the weight moved or the distance jumped by an insect and the size of the insect, to say that if the insect were as large as a man, a horse, or what-not, it could do most surprising things. This idea dies hard but can be passed with only a reference to Miall's discussion in his well-known 'The Structure and Life-history of the Cockroach,' where other discussions are cited.

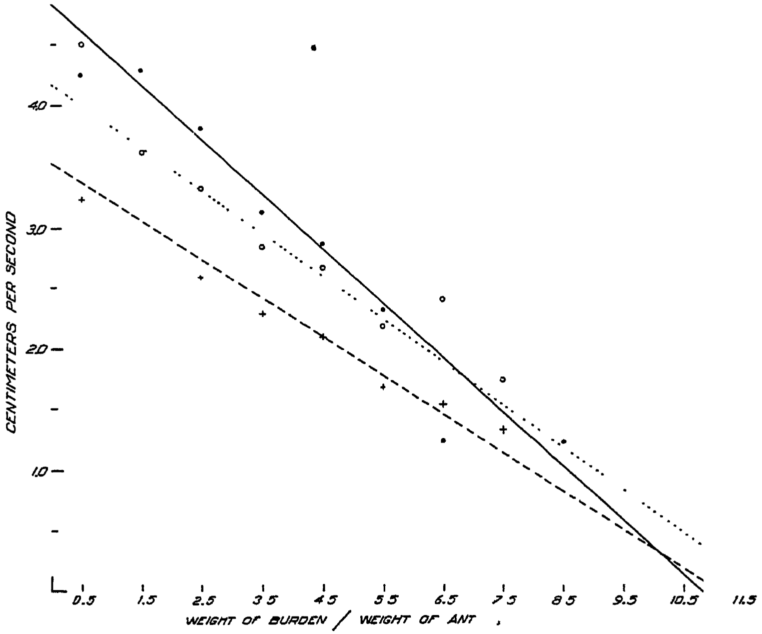

Fig. 2.—The relations between the average speed of *Atta cephalotes* and the relative weight of the burden carried on a + 4 per cent (dots), a —93 per cent (circles), and a + 76 per cent grade (crosses).

The present data do not tell very exactly how large a relative burden these ants can carry because, if the burden was so great that a carrier's speed was reduced to almost zero, other ants would gather around and by interferring would spoil the record. Fitting approximate straight lines to the graphs of average B/A plotted against average S and extending these lines to zero S we get an indication that a load of eleven or twelve times an ant's weight is about all it can carry. See Figure 2. The fact that each of these three lines (one for each of the path-grade considered) intersect the speed base-line at about the same point is another indication that some factor in addition to the weight of the burden influences the speed with which the burden is carried and that, were it not for this other factor, much larger pieces of leaf could be brought in.

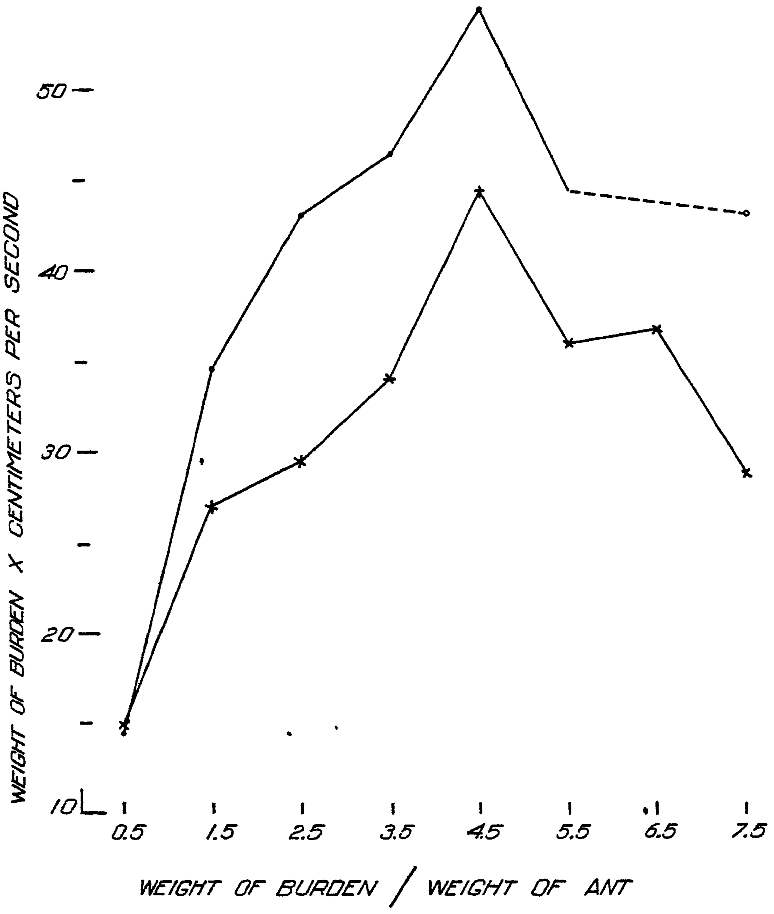

Fig. 3.—The relations between the burden-carring efficiency of *Atta cephalotes* and the relative weight of the burden carried on a + 4 per cent grade (dots) and + 76 per cent grade (crosses).

It would be interesting to know what is the maximum relative burden which it is PROFITABLE for an ant to carry. The colony may be considered as desiring that the largest number of milligrams of leaf be moved a given

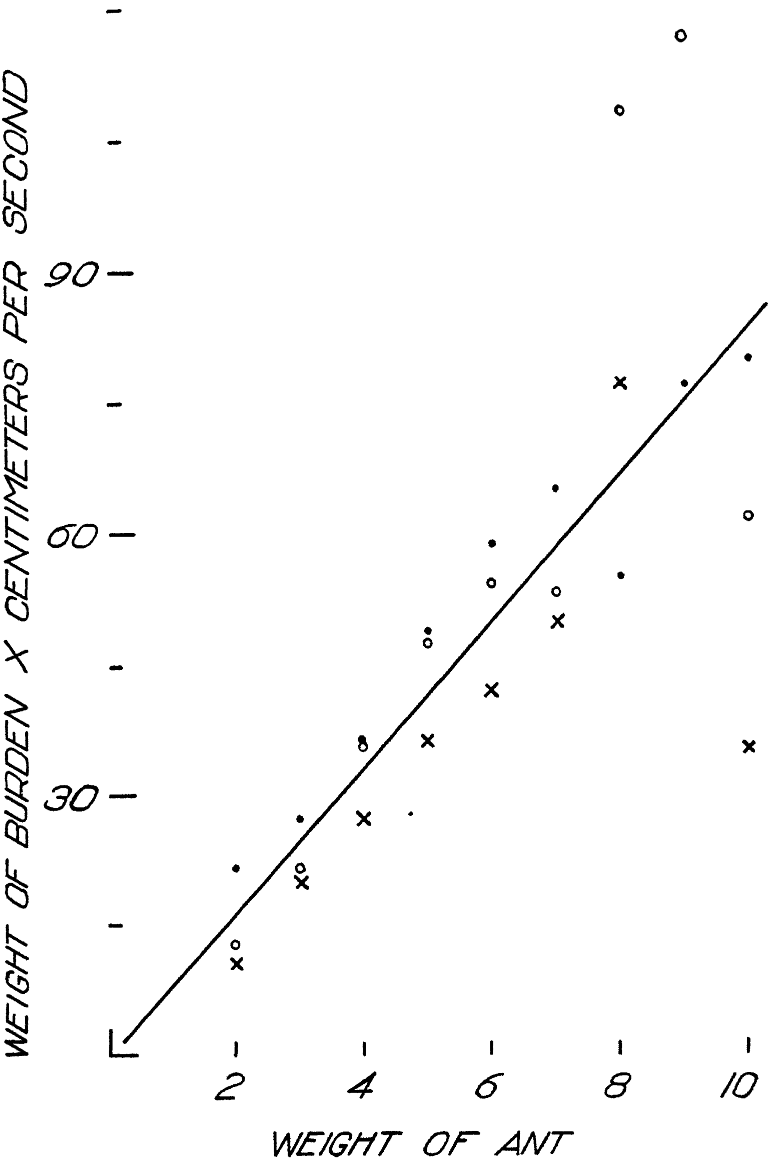

Fig. 4.—The relations between the weights of *Atta cephalotes* and their burden-carrying efficiency on a + 4 per cent (dots), a — 93 per cent (circles) and a + 76 per cent grade (crosses).

distance in a given time, in other words that burden times speed (BS) be as large as possible. Plotting BS against B/A for the practically level and the steep up-grade we get (Figure 3) curves which indicate that a load of about four and a half times the weight of the carrying ant is the most profitable load. Probably carrying this question into calculus would not give a more accurate answer because we have no basis on which to write a formula for the curves. However, since the average relative burden carried is only 3.1 times the weight of the carrier, it would seem that the ants might profitably cut rather larger pieces of leaf.

The relative burden carried decreases as the size of the ant increases. Thus, ants of the 2.25 mg. class averaged a load of 4.0 times their weight; 3.25 mg. ants, 3.6 times; 4.25 mg. ants, 3.3 times; 5.25 mg. ants, 3.1 times; 6.25 to 8.25 mg. ants, 2.6 times; and larger ones a load of only 1.9 times their own weight. We can not say definitely that this means that the smaller ants are more energetic than their larger sisters but the end-result is of that nature.

Which size of ant does the best work for the colony as judged by the milligram-centimeter transportation of leaf per second on a given trip? (Unless we mark individual ants we can not know how many trips per day the various sizes average.) The answer to this question is to be had by plotting BS against A, as is done in Figure 4. Combining the data of the three grades, practically horizontal, steep up, and steep down, we probably have a fair average of the whole trail. Apparently the relation is a straight-line one. Using the method of least squares and weighted averages we get, as a formula for the best line: Burden $\times$ Speed $= 8.67 \times$ Weight of Ant—1.20, the units being milligram, centimeter and second. For practical purposes it is sufficiently close to say that the transporting efficiency of these ants varied as eight and a half times the size of the ants as measured by their weight. Since the burdens carried varied by a lesser factor times the weight of the ant, it is clear that the greater efficiency of the larger ants is due to greater speed as well as to their carrying burdens that average absolutely larger although, as compared with the size of the ant, their burdens are relatively smaller than those carried by their smaller sisters. On this basis it seems just as well that the "minims," the exceedingly small members of the colony, stay in the nest attending the growing fungi, instead of attempting to do leaf-carrying work which their larger sisters do so much better.

Knowing the gradient of the path, the weight of the burden, the weight of the ant and the speed, one is tempted to hunt for a formula that would accord with the laws of mechanics and give us a measure of the power being used by the ants. I have spent in such an attempt an amount of time worthy of a better cause but have failed. Keeping in mind that an ant must lift and carry its own weight as well as that of its burden and that the strength of its muscles do not vary in simple proportion to their weight, putting in a factor to take care of trouble the ants have in balancing their burden, and making similar attempts to include other factors resulted in giving a theoretical speed that was too small on the up-grade or too great on the level. The missing factor seems to be that there is a speed on each grade which suits the ants and that they are not mere machines endowed with a given power which they use to the full according to the simple laws of physics. When going on the level they "take it easy" and when they come to an up-grade they use more power so that their speed, while not so great as on the level, is greater than any of my mechanistic formulæ anticipate.

In an attempt to discover something more about the different functions of ants of different sizes my plan of work for the early morning of March 27 was to station myself at the 50 cm. stretch called No. 5 on the liana trail before any ants reached there and then to collect and preserve the ants as they came along. They were picked off by hand, being careful to touch the liana as little as possible. The idea was to see whether the first lot of outgoing ants were chiefly relatively small ones, as I supposed they were. The plan failed in an interesting way.[1]

About fifteen feet after leaving the nest on the side of the hill the ants' trail descended to a roughly horizontal liana which was only about a foot from the ground near the beginning of No. 4. About eighteen feet beyond this point was No. 5. What happened this morning can best be told in chronological fashion.

7:10. The first outgoing ants have left the nest but have not yet reached No. 5.

7:15–7:20. Five ants (average weight 2.9 mg.) reached No. 5.

7:20–7:25. Fifteen ants (average weight 2.6 mg.) reached No. 5. In the little time they had to exhibit signs of disturbance before being picked off, most of them seemed puzzled and excited by something.

7:25–7-30. Nine ants (average weight 2.0 mg.) reached No. 5. Others are on the liana going back and forth just before crossing the line.

7:30–7:35. Only two small ants (0.6 and 1.5 mg.) crossed the line onto No. 5. Two *Cryptocerus umbraculatus* came along apparently undisturbed by anything.

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[1] Not entirely failed, however. Of the 72 ants collected as described in what follows, 19 averaged 1.25 mg ; 30, 2 25; 14, 3.25; 6, 4.25; 2, 5 25; and one weighed 6.2 mg. In other words, these early-going ants were really small ones, averaging about 2.5 mg.

7:35–7:45. No leaf-cutting ants came on No. 5 in these ten minutes. Most of those that had nearly reached this point had gone back a considerable distance toward the nest. One *Cephalotes atratus* and two *Cryptocerus umbraculatus* came and were collected. Then the leaf-cutters seemed to get another urge to follow the day's routine.

7:45–7:50. The indication of this is that thirteen (average weight 2.3 mg.) reached No. 5 in this five-minute period. One *Neoponera striatinodis* also came.

7:50–7:55. Most of the outgoing ants are stopping before they reach No. 5 but five small ones (average weight 1.1 mg.) crossed the line, also two of *Cryptocerus umbraculatus.*

7:55–8:00. No leaf-cutters but two of *Cryptocerus umbraculatus.* At this time a dozen or more of the leaf-cutters are congregated about two feet before reaching No. 5. They seem to be waiting for something or else they were afraid to go on. At any rate, they went back.

8:05–9:05. In this entire hour only six leaf-cutters reached No. 5. There were, however, eleven of *Cryptocerus umbraculatus,* each being collected as it came along but NONE having acted as though there were anything unusual about the trail. The sun was bright all of this time and a number of leaf-cutters, perhaps forty or fifty, are congregated about the nest as though waiting for some signal. A few are wandering off the trail, going on a small branch near No. 4 to the ground.

In all of this time no "soldiers" had appeared and, so, either they do not exercise their supposed function thirty feet from the nest or what I did was not looked upon as an "attack." Notice that two hours have passed since the first ants started out to get leaves. The day's activities should have been well advanced and leaves coming in rapidly. At 8:50 I broke some pieces of leaf from a bush and dropped them near the nest opening. The ants took them in and at 9:00 a crowd started out of the nest and along the liana. The reaction was so promising that at 9:02 I dropped some more leaves on the ground near the nest and then went ahead to No. 5 to watch results.

9:05–9:10. The first ant to come near No. 5 seemed to dislike the trail there and turned back at once. Of a large number that almost crossed the line all but ten turned back. These ten were rather large, average weight being 3.8 mg.

9:10–9:15. The "wave" of outgoing ants had not quite stopped. Seven (average weight 2.1 mg.) crossed the line but the others went back and traffic in the forward direction entirely ceased.

Meanwhile, those ants which had wandered off of the trail near No. 4 and onto the ground began taking pieces of fallen leaves to the nest. At 9:40 ants were coming down No. 3 in large numbers, some going to the ground and coming back with pieces of leaves, others going on the regular trail but turning back at some point before crossing the line onto No. 5. No ants having ventured on this fatal strip during the past twenty-five minutes, I decided to stop the plan of collecting them.

At 9:43 one reached the edge of No. 5 but turned back. More are coming and at 9:46 eighteen are in the crowd milling about near the line. At 9:47 one crossed No. 5 and went about three feet beyond; then returned across No. 5 to the crowd that was stalled there. At 9:48½ five ants broke through whatever was preventing them from going ahead and then the rush began. Between 9:50 and 9:55 twenty-four went across, eight coming back before they reached the tree. The first ant carrying a leaf on the return trip passed No. 5 at 10:24. In the succeeding five minutes thirteen with leaves and sixteen without leaves passed going toward the nest; there were twenty-one outgoing ants. The arrival of these leaves at the nest caused great commotion there and a perfect upwelling of workers that started along the trail at once. There was no more hesitation at No. 5.

All of this proves very little about ants but in certain ways it seemed interesting. The finale was a beautiful demonstration of the effect which follows the first arrival of a band of workers bearing fresh leaves. The stimulus of the few pieces which I dropped on the nest or that of the fallen leaves which the workers carried in from the ground near No. 4 was as nothing compared to the explosive effect of what happened when the regular line of fresh leaves arrived.

Most clearly, what I did at No. 5 made an impression upon the remaining ants which resulted in overcoming their habit and—may one say it?—the urge to go along the liana for leaves to cut. The possibility that the captured ants communicated their distress by sound[1] may be ruled out at once, since whatever it was persisted long after the captured ants were dead.

Of the remaining possibilities, there is the probable and generally accepted factor of odor but it will have been noticed that this odor must have acted at a distance because the outgoing ants stopped before actually reaching No. 5; see, for example, the notes for 8:00 A.M., when the ants were huddled two feet away. If it was odor, it may have been the odor of my fingers when they accidentally touched the liana in picking off the ants or it may have been some odor given off by the captured ants. I had previously determined that by rubbing the liana trail with my fingers I could so affect not only the leaf-cutters but also the other species of ants traveling this trail that they would hesitate when they came to the spot and even occasionally turn back. However, in today's work I took pains to avoid as much as possible touching the liana. Since ants of other species were not in the least disturbed by what I did today it seems clear that I really had avoided leaving an odor which would interest them. On the other hand, the leaf-cutters are much more disturbed by today's events than they ever were when I deliberately rubbed the trail.

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[1] Lutz, 1924, 'Insect Sounds," Bull. Amer. Museum Nat. History, L, pp. 333–372.

This might indicate that the odor, if odor it be, is caused by the captured ants, but in previous days when collecting the more than four hundred ants carrying burdens I exercised no care, either as to touching the liana with my fingers or as to squeezing the ants, and no such effect as this was evident. Accordingly, one wonders whether odor was really the controlling factor.

If it was neither sound nor odor that upset the routine of these ants, what was it? I have a notion that upsetting the routine was what upset it. To an extremely methodical man this will be more understandable than it is to those of the other extreme; and ants, like insects in general, are quite methodical.

I have tried to picture in these notes how the colony, if undisturbed, does very much the same thing day after day, beginning with the first band that, when some condition, possibly light, becomes right, suddenly leaves the nest to go along the trail for the distant tree. Not all of this first band, and possibly none of them, go directly to the tree but, having gone a certain distance, an ant turns back while others go a bit farther, and so on. Finally the tree is reached and some ants come back with leaves, others without. When the leaves reach the nest, the stream of outgoing ants, which has rarely entirely stopped, is suddenly increased. This is routine; and a striking part of it is that at all times, even when the main body of moving ants is out-bound at the very start of the day a given ant does not go far before it meets at least one ant going in the opposite direction and stopping to exchange antennal touchings.

Now, when some circumstance such as an inquisitive human brings it to pass that there are no returning ants, it does not seem strange that the routine would be upset. In going to the office mornings I start off alone. I might not think it strange if I passed no one at first but if, in a street where there are ordinarily many acquaintances coming and going, I saw no one, I would be very apt to be at least surprised. What I did next might not be what my own brother would do in a similar case and certainly might be very different from what an ant might do even if an ant could think and was in a similar situation.

I fully realize that, even if one admits that it was the lack of ants returning from the front that demoralized a column thirty feet long, to say nothing of the hundreds of ants waiting in the nest for some signal, one can still avoid the necessity of saying that ants think by saying that these ants were deprived of the stimulus (incoming ants) for continued progression in an outward direction. Perhaps, if this is found by further work to be really what happened, it will be desirable to coin a new work ending in "–tropism" and to say that this word explains the deed. Meanwhile, an *Atta* colony remains a remarkable bit of natural history.

AMERICAN MUSEUM NOVITATES

Number 389
Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City
Dec. 5, 1929

56 9, 53K (1183 75 9)

A NEW FOSSIL TOOTHED WHALE FROM FLORIDA

BY REMINGTON KELLOGG

Through Dr. W. D. Matthew, the American Museum of Natural History received from the American Cyanamid Company, Brewster, Florida, a portion of the conjoined lower jaws of an extinct toothed whale. Hydraulic power is used by this company in working their pit and most of the cetacean material unearthed is unavoidably damaged by this method of operation. Some of the specimens crumble when the stream of water strikes them and others break up when they fall to the bottom of the pit. Although it is impossible to obtain undamaged specimens, many of those obtained from these deposits are of unusual interest. It is fortunate that some of the officials recognize the importance of such specimens and place those that are recovered in institutions where they will be preserved. These pits are excavated in what are known as the land pebble phosphate deposits. According to Dr. E. H. Sellards,[1] this pebble conglomerate may have accumulated under either marine or estuarine conditions, probably during late Miocene or early Pliocene time. Considerable uncertainty exists as to the precise age of these deposits, and this is due mainly to the curious mixture of land mammals, which are held to be of Lower Pliocene age by Dr. Matthew, and pelagic mammals, which occur elsewhere in deposits of Miocene age. One explanation of this occurrence would be that a marine deposit of Miocene age was reworked during Pliocene time, and remains of Miocene pelagic mammals were redeposited along with remains of contemporary Pliocene land mammals. This explanation hardly suffices, for I have been informed by Barnum Brown that he personally witnessed the excavation of an entire skeleton of a sirenian, possibly *Metaxytherium*, in one of these pits, but before the hydraulic apparatus could be shut off the entire specimen crumbled and broke when it fell. It is barely possible that this sirenian may have belonged to the Pliocene *Felsinotherium*, but no remains of this animal have ever been reported from these deposits. One would hardly expect to find complete skeletons of Miocene pelagic mammals in reworked deposits of Pliocene age. Of the three known genera of extinct porpoises found in these deposits, *Cyrtodelphis* [=*Schizodelphis*] has a geological range in Europe from the Lower to the Upper Miocene. *Pomatodelphis* occurs in the Middle Miocene of France, while the physeteroid hereinafter described is either unknown or not as yet recognized elsewhere. The sirenian, *Metaxytherium*, occurs in European deposits of Lower and Middle Miocene age. In so far as the pelagic mammals are concerned, no subsequent finds have been reported which would modify the writer's statement[1] published in 1924. For the privilege of making a study of this specimen I am indebted to Dr. George Gaylord Simpson.

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[1] E H Sellards, 1915 The pebble phosphates of Florida. 7th Ann. Rept. Florida State Geological Survey, pp. 58, 63.

Kogiopsis, new genus[2]

Diagnosis.—Skull unknown. Mandible incomplete, but symphysis estimated to comprise one-third of its length. In general conformation similar to corresponding portions of mandibles of *Kogia*, but differs in having broader symphysis, six instead of eight teeth on symphysial portion of ramus, alveoli not extending over so far on lateral surface of ramus, and in addition is much larger. Rami firmly ankylosed in region of symphysis; dorsal surface of symphysis rather broad and flat; lateral surfaces of rami slope to mid-line of ventral face of symphysis. Large alveoli located on upper outer edge or angle of mandible. Ten teeth in each mandible, of which six are lodged in symphysis. Teeth long (3 to 4 inches in length), somewhat curved, with small crowns, without distinct neck, and rather closely spaced. Outer surface of cement wrinkled and ornamented with coarse longitudinal grooves. Outer surface of internal cone of dentine encircled by fine ridges.

Kogiopsis floridana, new species

Type.—Amer. Mus. No. 20470. Symphysial portion of lower jaws, with eleven teeth in place. Collected by W. D. Matthew in 1924.

Horizon and Locality.—Land pebble phosphate deposits. American Cyanamid Company pit at Brewster, Polk County, Florida.

As will be observed from the photographs, this specimen exhibits some unusual features for a physeteroid whale. Contrasted with other known fossil sperm whales, the lower jaws seem to be unusually short. No characters are known which will with certainty distinguish mandibles of sperm whales of the family Physeteridæ from those belonging to the family Kogiidæ. The recent genus *Kogia* has a mandible with large alveoli placed on the upper outer angle of the ramus, and the intervening septa are either reduced or composed of spongy bone; the teeth are directed outward and forward. On the mandible of *Physeter*, the upper outer angle or edge is not disrupted by the alveoli, and the teeth are directed upward, although their apices may curve backward. This method of implantation of the teeth occurs in the mandibles of three genera of fossil Physeteridæ, but it is nevertheless true that the lower jaws of most of the recognized fossil genera are unknown. In this one feature, which may be of no consequence, the Florida specimen does agree with the recent genus *Kogia*. Whether or not this peculiarity is of sufficient importance to warrant a family allocation is uncertain, and for this reason this fossil cetacean is tentatively referred to the Kogiidæ. Structurally these lower jaws do resemble those of *Kogia*, and this whale

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[1] R Kellogg, 1924. 'Tertiary pelagic mammals of eastern North America.' Bull. Geol. Soc America, XXXV, p. 765. Dec. 30.

[2] *Kogia: ὄψις*—aspect; in allusion to the resemblance of these fragmentary remains to the mandibles of *Kogia*.

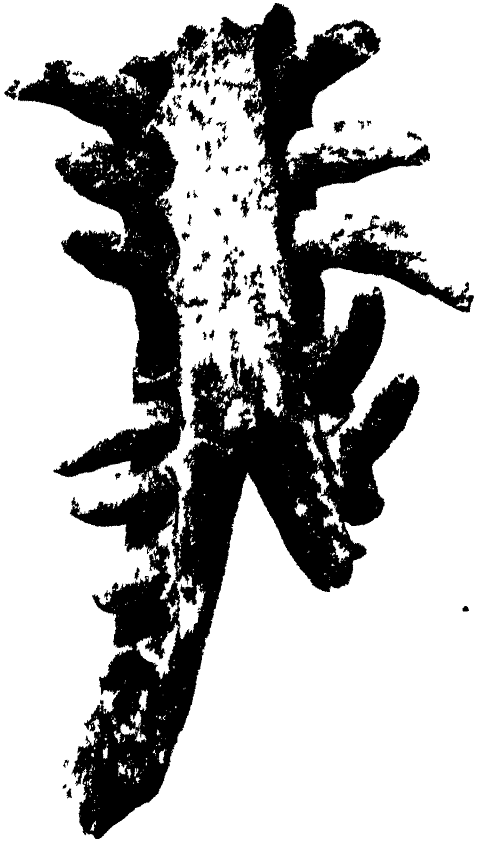

Fig. 1. *Kogiopsis floridana*, new genus and species. Type, A. M. No. 20470 Dorsal view of lower jaws.

undoubtedly is a relative of members of one or the other of these two families of cetaceans.

In contrasting the relative peculiarities of these two families, it will be seen that *Kogia* has 12 or 13 and sometimes as many as 15 teeth in each mandible, of which 8 are lodged in the symphysis; the symphysis is slightly more than half the length of the toothrow and less than one third the length of the mandible. In *Physeter* there are from 19 to 27 teeth in each mandible, younger individuals having more teeth than old adults; the symphysis is nearly coextensive with the tooth row and is equivalent to more than half the length of the mandible. In both *Kogia* and *Physeter* the apex of the internal cone of dentine forms the crown of the tooth, and there is no enamel.

The symphysial region of these lower jaws differs from the corresponding portion of another cetacean from this same locality, which was described and figured by Dr. Glover M. Allen,[1] in having a much wider interval between the tooth rows, alveoli placed on outer lateral edge of mandibles, teeth directed outward and forward, large and closely spaced alveoli and coordinate instead of alternating teeth. The referred specimen mentioned by Dr. Allen, which was figured by Sellards,[2] belongs to a long snouted porpoise. This specimen formerly belonged to the International Agricultural Corporation, and was presented to the United States National Museum through the late Ned Hollister. Additional observations on this specimen will be presented in a forthcoming paper. The specimen in the Museum of Comparative Zoology may have belonged to a young individual, as the line of the symphysial union of the jaws is quite obvious on the dorsal surface. On the specimen in the American Museum, the line of ankylosis is well nigh obliterated on the dorsal and ventral surfaces, but can be traced. It is possible that differences in age may account for the dissimilarities enumerated above. It seems best to wait for additional material before making any definite allocation of the specimen handled by Dr. Allen.

As to the possible relationships of this Florida physeteroid with *Orycterocetus*, one can do no better than cite the observations of Joseph Leidy,[3] who states that the genotype *O. quadratidens* was originally based on two teeth and small fragments of an upper jaw from the Miocene of Virginia. The lower jaws of this species as well as the other referred species either have never been found or never recognized among the many remains of fossil cetaceans obtained from nearby Maryland and Virginia. Hence no direct comparisons can be made between corresponding portions of these two physeteroids. The fragment of the upper jaw accompanying the teeth was about eight inches long, with alveoli for as many teeth. "The alveoli were separated by thin partitions, and their bottom was separated from the dental canal by a thick layer of porous bone Two alveoli, perfect at their outer parapet, are an inch and three-fourths deep by an inch in diameter." Leidy describes the teeth as being "long and conical, one nearly straight, the other strongly curved. Near the apex they are rather ovoidal in transverse section, but towards the base assume a more quadrate character." The fine longitudinal ridges observed occur on the internal cone of ossified pulp and dentine of teeth of most fossil physeteroid whales, although these ridges can not be seen when the outer layer of cement is intact. In size these two teeth correspond rather closely with those of the Florida physeteroid. The available material, however, does not justify the allocation of the Florida physeteroid to the genus *Orycterocetus*.

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[1] G. M. Allen. 1921. 'Fossil Cetaceans from the Florida Phosphate Beds.' Journ. Mammalogy, II, No. 3, pp. 154–157, Pl. XII, fig. 14, August.

[2] E. H. Sellards, *op. cit.*, p. 103, fig. 32.

[3] J. Leidy, 1869. Journ. Acad. Nat. Sci. Philadelphia, (2) VII, pp. 436–437, Pl. XXX, figs. 16–17.

Fig 2. *Kogiopsis floridana,* new genus and species A M. No. 20470. Lateral view of left mandible

Of the several genera of fossil European sperm whales, the teeth of *Physeterula dubusii* resemble most closely those of the Florida species, though the mandibles have a much longer symphysis. This sperm whale has a skull about 54 inches long, and according to Professor O. Abel[1] the mandible and maxillary are furnished with teeth. There are 20 teeth in each mandible, of which 12 are lodged in the symphysis. The tips of the teeth are compressed, and the septa between the alveoli are not less than 5 mm. The largest teeth are 130 mm. long, and the smallest are about half that length, or from 50 to 60 mm. The diameter of the root of a large tooth is 30 mm. The crown ends in a point, without enamel, and is formed solely of dentine. The apex of the tooth is encircled by a faint excrescence or swelling which marks the upper limit of the cement. The well worn ends of the teeth in the mandible point to the existence of functional teeth in the upper jaw. The wear is most marked on the posterior surfaces of these teeth. The basal half of the root is ornamented with ramifying deep longitudinal grooves. Peculiarities in the mandible and in the teeth distinguish the Florida specimen from *Physeterula*.

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[1] O Abel 1905. 'Les Odontocètes du Boldérien (Miocène supérieur) d'Anvers Mém Mus roy d'hist nat de Belgique, Bruxelles, III, pp 74–82, figs 11–12

Judging from the curvature of the rami, it would appear that a short-jawed type is here represented and that the symphysis comprises about one-third the length of either jaw. The symphysial portion of the conjoined lower jaws seems to be nearly complete, and more of the left jaw than of the right is preserved. Although the distal end of the symphysis is somewhat eroded, the direction and close approximation of the anterior pair of alveoli, as well as the abrupt oblique upward slope of the ventral surface, indicate that very little has been destroyed. The left ramus measures 356 mm. in a straight line from the median line of the anterior end of the symphysis to its posterior broken edge, while the right ramus measures 259 mm. in length. The anteroposterior diameter of the symphysis, as preserved, is 202.5 mm. At the proximal end the depth of the symphysis is 80 mm. and at the level of the ninth pair of teeth 58.5 mm. The breadth of the combined lower jaws at the proximal end of the symphysis is 104 mm. and at the distal end 84 mm. At the posterior end of the symphysis the rami diverge at an angle of forty degrees. The lower border of the left ramus commences to curve outward at the level of the third alveolus, and the ramus narrows transversely toward the rear. The symphysis is heavy and solidly ankylosed, but the rami are not unusually deep in this region.

Viewed from the side, the symphysial portion of the jaws curves upward from the posterior to the anterior end. The distal end of the symphysis is truncated obliquely in a dorsoventral direction. The dorsal surface of the symphysis is flat, rather wide, and there is a faint indication of a longitudinal groove along the line of contact of the rami. On the specimen figured by Dr. Allen, the interalveolar region is rather narrow and the line of contact of the rami is deeply impressed. There are several small mental foramina on the outer surfaces of the rami in the region of the symphysis which are continuous posteriorly with similar foramina 10 to 15 mm. below the level of the alveoli.

All of the teeth are loosely implanted in the alveoli, which have the appearance of being much too large. The alveoli range from 24 to 34 mm. in diameter, and are rather closely spaced. The alveolus for the sixth tooth on the left side is 44.8 mm. deep, while the corresponding one on the right side is 38.2 mm. deep. On the left ramus the first or proximal alveolus is 38 mm. deep and the second is 41.5 mm. deep. The third alveolus on the right side is 46 mm. deep. The large dental canal that extends through the mandible comes within 3 mm. of this alveolus.

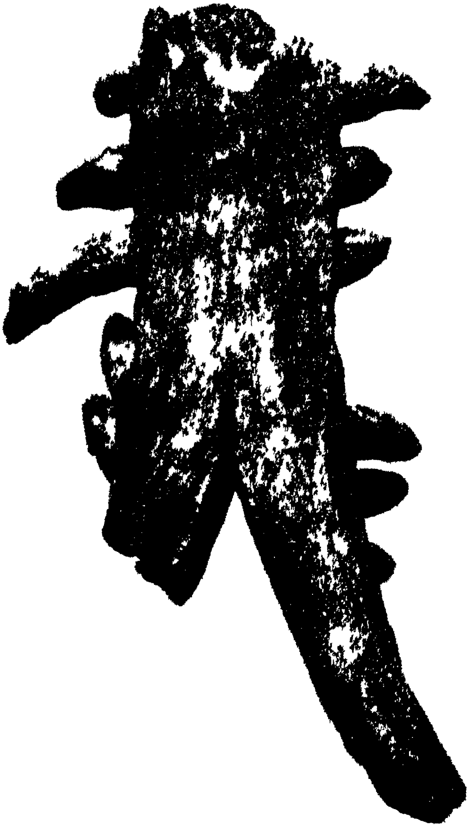

Fig 3. *Kogiopsis floridana,* new genus and species Type, A. M. No 20470. Ventral view of lower jaws.

The teeth are long, oval in cross section, and some of them are rather strongly curved. Their apical ends curve backward and are somewhat compressed from side to side. No distinct neck or constriction below the assumed limits of the crown can be observed on any of these teeth. The seventh tooth on the right side projects 81 mm. beyond the level of the alveolus, while the third tooth of the left side projects 43.7 mm The seventh tooth, judging from those in front and behind, it not inserted to the full depth of the socket. Since most of these alveoli are larger than the teeth, the latter may have been held in place by a ligamentous gum.

All of the teeth are imperfectly fossilized and the cement especially is rather soft and pithy. The teeth fracture and crumble very readily. The summit of the crown on all of these teeth is abraded, and the ornamentation of the enamel, if originally present, is not ascertainable. Judging from the present condition of the teeth, the crowns were worn down during life and their present condition is only partially due to imperfect preservation. The crowns apparently were relatively small in comparison to the roots. All of the teeth possess a rather thick outer coat of cement. The eighth tooth on the left side is broken below the crown, showing the internal cone of ossified pulp and dentine, and the outer layer of cement. The outer layer of cement is lighter in color than the dentine and its thickness is equivalent to about one-sixth of the transverse diameter of the tooth at the corresponding level. The cement coat actually measures 3.5 mm. in thickness on the outer surface. On many of the teeth the outer surface of the cement is noticeably wrinkled or ornamented with coarse longitudinal grooves varying in number and depth on the different teeth. The internal cone of pulp and dentine is built up from concentric layers, each about one millimeter in thickness. On the seventh tooth in the left ramus, the outer layer of cement is partially destroyed, exposing the inner cone of dentine, which is encircled by thin ridges usually referred to as annular lines of growth. The pulp cavity is closed on the distal ends of these teeth. The roots of all these teeth are very large and are thickest about half way of their length.

The most obvious distinction between these teeth and those of *Orycterocetus quadratidens* is the absence of fine longitudinal ridges on the outer surface of the internal cone of dentine.

MEASUREMENTS OF MANDIBLES (in millimeters)

	Right ramus	*Left ramus*
Greatest length of mandible	259	356
Antero-posterior diameter of proximal alveolus	x	29
" " " first interspace	x	3
" " " second alveolus	x	24
" " " second interspace	x	3
" " " third alveolus	24	28.5
" " " third interspace	4.5	3
" " " fourth alveolus	27.5	26
" " " fourth interspace	3	3
" " " fifth alveolus	32	34
" " " fifth interspace	1.5	3
" " " sixth alveolus	27.5	30.5
" " " sixth interspace	2.5	5
" " " seventh alveolus	36	33.5
" " " seventh interspace	3	3
" " " eighth alveolus	31	31
" " " eighth interspace	3.5	3
" " " ninth alveolus	35.5	30
" " " ninth interspace	4	4
" " " tenth alveolus	27	23.5
Proximal tooth projects beyond alveolus	x	x
Second " " " "	x	x
Third " " " "	x	43.7
Fourth " " " "	59	53
Fifth " " " "	67	59
Sixth " " " "	x	x
Seventh " " " "	81	62
Eighth " " " "	66.5	46.3+
Ninth " " " "	63	55.1+
Tenth " " " "	x	x
Anteroposterior diameter proximal tooth at level of alveolus	x	x
Anteroposterior diameter second tooth at level of alveolus	x	x
Anteroposterior diameter third tooth at level of alveolus	x	23
Anteroposterior diameter fourth tooth at level of alveolus	27	23.5
Anteroposterior diameter fifth tooth at level of alveolus	27	25
Anteroposterior diameter sixth tooth at level of alveolus	x	x
Anteroposterior diameter seventh tooth at level of alveolus	28	26.5

MEASUREMENTS OF MANDIBLES (in millimeters)
(continued)

	Right ramus	*Left ramus*
Anteroposterior diameter eighth tooth at level of alveolus	26.5	27
Anteroposterior diameter ninth tooth at level of alveolus	26.3	25.5
Anteroposterior diameter tenth tooth at level of alveolus	x	x

AMERICAN MUSEUM NOVITATES

Number 390

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

Dec. 6, 1929

56 9,10 14,31,4

THE DENTITION OF *ORNITHORHYNCHUS* AS EVIDENCE OF ITS AFFINITIES

BY GEORGE GAYLORD SIMPSON

INTRODUCTION

In 1888, E. B. Poulton announced the discovery of true teeth in *Ornithorhynchus*, long supposed to be completely edentulous. Later morphological, histological, and embryological data were published by the same authority (1889), by Oldfield Thomas (1890), by C. Stewart (1892), and by Wilson and Hill (1907).

In his paper (1890, p. 131), Thomas said, "In any case, since the form and structure of teeth are of necessity the chief means of determining the evolutionary history of the Mammalia, the discovery now made, in giving us genuine Monotrematous teeth to work from, provides one of the most important aids to the elucidation of the systematic position of these anomalous mammals that has yet been obtained." Thomas himself, after a fruitless search for any similar teeth, abandoned this task, however, and no serious or detailed effort in this direction seems yet to have been made.

In the very extensive discussion of the affinities of the monotremes during the last forty years, the teeth have usually been ignored. The principal exceptions are Cope's view (1888), often discussed or repeated, that the teeth suggest affinities with the Multituberculata, Ameghino's belief (1908) that they agree with other supposedly edentate-like characters, and Abel's comparison (1922, 1926) with the Miocene mammal *Desmostylus*.

An attempt is here made to gain a somewhat firmer basis for the study of the external morphology of the dentition of *Ornithorhynchus* and to examine the various theories which have been or can be advanced regarding their origin and relationships.

MATERIALS

Thanks to the good offices of Dr. C. Anderson of the Australian Museum and to the generosity of Mr. H. Burrell, three specimens have been available. With the several specimens illustrated in the papers cited below, these make possible a truer understanding of the range of variation and of the essential characters of these degenerate teeth.

The specimens were collected by Mr. Burrell in November, 1927, on the Nampi River and were kept by him in his "platypus weanery." They died at the ages of 8½, 10, and 11 weeks, and are here designated specimens A, B, and C, respectively. None had taken any harsh food, and the teeth are unworn. In A, calcification is far advanced, but not complete. In B and C, calcification was complete and the teeth functional. In these two the minute anterior upper teeth were absent and had probably been shed. This material was also studied independently by Dr. Robert Broom on the occasion of a recent visit to the Museum.

The specimens were unfortunately lost, and publication was long delayed in the hope of recovering them, but this was unsuccessful and the paper has been completed from notes and drawings which are believed to be accurate.

REPLACEMENT AND DENTAL FORMULA

Most of our knowledge of the development of the teeth in *Ornithorhynchus* is due to Poulton (1889) and to Wilson and Hill (1907). The latter have shown that four quasi-permanent teeth and probable vestiges of one more are present in each jaw. In the upper jaw a vestigial dental papilla is followed by the three functional teeth. Posterior to these they found the dental lamina bulky, and Poulton apparently found it papillated. In the lower jaw there is no equivalent of the first upper papilla. Corresponding to the first functional upper tooth is a calcified but functionless vestigial tooth, followed by the three functional lower teeth.

The status of replacement in this genus is questionable. Aside from still more doubtful evidence, the only trace of a deciduous dentition is seen in a series of epithelial nodules five in number and placed near the main cusps of the two larger functional teeth in each jaw. It seems probable that these are vestiges of dental papillæ, but this is open to some doubt. If this view is correct, they may represent the vestiges of five deciduous teeth, or of five teeth once discrete but serially equivalent to the two large functional teeth, or (most probable if they are really remains of a deciduous dentition) they may represent the apices of the degenerate but once unified enamel organs of two teeth only.

The determination of a complete dental formula for *Ornithorhynchus* is impossible. Wilson and Hill believe the first functional upper tooth and the calcified anterior vestige in the lower jaw to be the last premolars, although, since there is no sign of replacement here, this has little basis beyond the small size of these teeth. Leche and others have claimed that the functional teeth of *Ornithorhynchus* are lacteal and that the epithelial nodules represent a prelacteal series, but this also is obviously uncertain. Homologization with the teeth of other mammals is hardly possible in this degenerate dentition, but at least the two largest teeth in each jaw are analogous to molars in form, position, and function.

MORPHOLOGY

The first upper tooth is present in specimen A as a single high, slender, sharp cusp, the apex of which was just protruding from the gum. The figure and model of Stewart's specimen, on the contrary, show it as a minute elongate tooth with a flattened crown bearing about seven indefinite, low, rounded cuspules. Poulton's sections (1889, Pl. II, figs. 1–3) agree more with our specimen A, showing a very high, slender tooth with a single main cusp with a smaller external accessory cusp doubtfully present.

The second and third upper teeth are relatively large, of about the same size, and similar in pattern. The three new specimens show unusual variability in size and form, still more striking on comparison with Stewart's and with Thomas' figures. Each tooth is definitely divided into two subequal parts by a median constriction and broad coronal basin. Each half bears a high internal cusp, slightly compressed anteroposteriorly and generally inclined forward. A single crest may run externally from the apex of a cusp, but in most cases there are two, making the cusp crescentic. The external margin bears numerous small cuspules so variable in number and in prominence as to show no constant plan. There is perhaps a tendency for the development of a prominence opposite each of the two internal cusps which may be significant but which is vague and uncertain. Fully calcified teeth have anterior and posterior crenulated cingula.

The first lower tooth is more or less definitely triangular in all cases, but with only two constant cusps. The more prominent of these is anteromedian, its anterior face convex and simple, its posterior face concave, generally with a suggestion of a median vertical crest or swelling, and bounded by the more or less sharp wings of the subcrescentic cusp. The median part of the crown posterior to this cusp forms a rather irregular basin. The second main cusp is at the postexternal angle of the crown. It is slightly more conical than the first, but tends to be produced into a rather inconspicuous transverse crest. The internal and posterointernal margins of the crown bear a number of smaller cuspules of varying size. Some are fairly prominent, but none are at all constant.

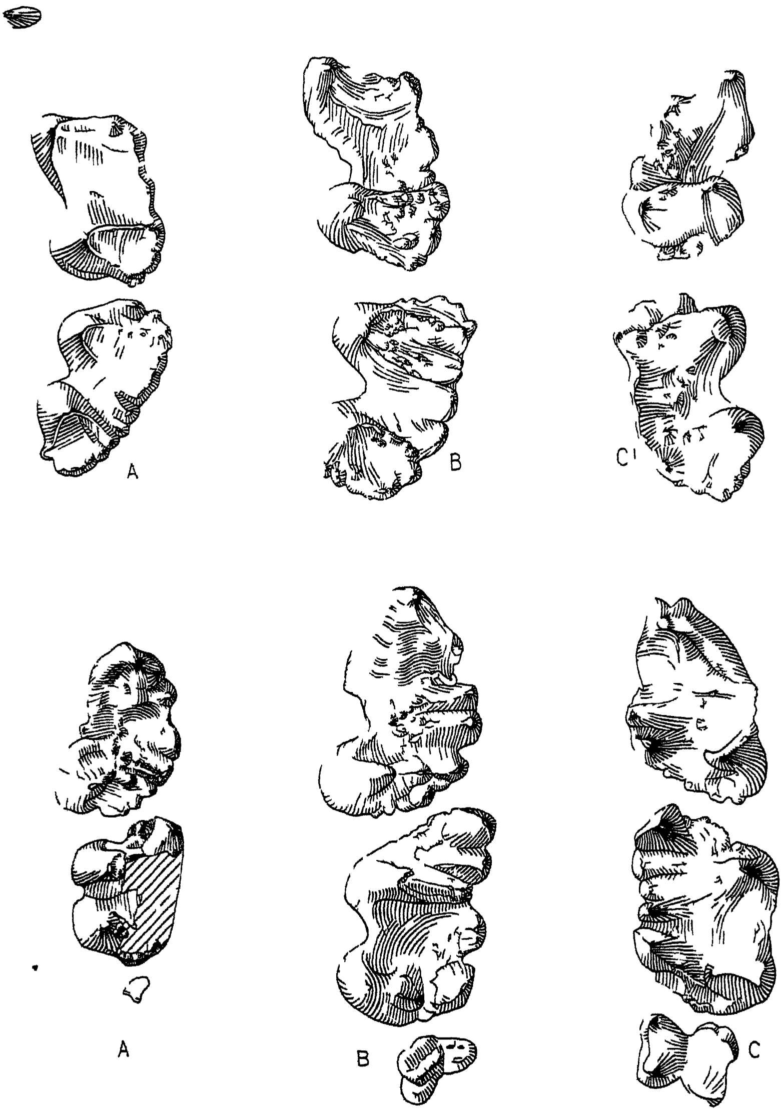

Fig 1 —*Ornithorhynchus anatinus* Crown views of the true teeth of three individuals A, 8½ weeks old B, 10 weeks old C, 11 weeks old A^1, left upper teeth A, left lower teeth B^1, left upper teeth B, left lower teeth C^1, right upper teeth C, right lower teeth All six times natural size

There is no apparent tendency to form a third main cusp to complete a trigon. There is a crenulated posterior cingulum, but no anterior cingulum on the present specimens or those previously figured.

The second lower molar is subquadrate and broadly similar to the two large upper teeth. It has a median basin and constriction and two main external cusps. These are not definitely crescentic, as in some of the upper teeth, but tend to be elongated into transverse crests. The internal margin bears a number of variable cuspules. The antero-internal cuspule is fairly prominent and more or less constant and there is generally a small basin between it and the more anterior of the main cusps. There is a crenulated posterior cingulum.

The third lower molar is small and very inconstant in form. In specimen A, calcification has proceeded only to the point of forming a single indefinite cusp. In B, the tooth is roughly triangular, with a rather vague and irregular low central cusp and internal and posterior expansions. In C, it is quadrate with four fairly distinct cusps and a median basin. In Stewart's specimen it is oval with a blunt central cusp and a surrounding cingulum, higher and broader anterointernally and posteriorly—somewhat similar to specimen B.

In the present specimens, as well as in those of Poulton, Thomas, and Stewart, the calcified teeth are not only discrete but well spaced, no two being in contact in either upper or lower jaws. Wood Jones (1923, p. 50), on the contrary, states that the three teeth (of the lower jaw at least) eventually fuse into a common calcified mass, extremely brittle in composition. Confirmation of this remarkable condition by publication of more detailed data and figures is not, so far as I know, available, and is very desirable. Wood Jones' rather schematic figure (Fig. 32, p. 53) is also remarkable in its basic disagreement with all other published data, showing a quadrate first tooth with four main cusps, a subtriangular second tooth with three or four main cusps, and a minute unicuspid third tooth.

OCCLUSION

The true teeth of *Ornithorhynchus*, like the horny plates which follow them, are adapted only to crushing, without shearing or grinding. Occlusion is sufficiently close to prevent any considerable movement of the lower jaw in a horizontal plane, but is by no means exact in the unworn teeth.

The first upper tooth is anterior and internal to the first lower and is apparently functionless. The anterior cusps of the second and third upper teeth occlude in the median basins of the first and second lowers, respectively, more or less tightly clasped between the main cusps of the lower teeth. The posterior cusps of the second and third uppers fall between the first and second and the second and third lowers respectively where they come in contact with adjacent cingula but are not, in the present specimens, received in definite basins or heels. The external margins of these two upper teeth overhang the elevated outer side of the lowers.

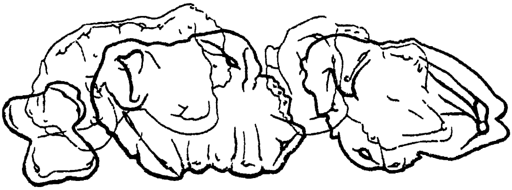

Fig. 2—*Ornithorhynchus anatinus.* Diagram of occlusion of true teeth, based on specimen C. The darker lines represent the lower teeth. The top of the drawing is external and the right is anterior. Six times natural size.

The anterior cusp of the first lower tooth occludes anterior to the first upper and has no apical contact, while the anterior cusp of the second lower tooth falls between the second and third upper teeth and against the anterior cingulum of the third. The posterior cusps of the first and second lower teeth are received in the median basins of the second and third upper teeth respectively. The third lower tooth comes in contact, in varying degrees and ways in the three specimens, with the rather broad and somewhat basined posterior heel of the third upper tooth.

From these relationships it follows, as pointed out by Wilson and Hill, that the first and second lower teeth correspond to the second and third upper teeth and that the third lower and first upper correspond to teeth lost or no longer calcified in the opposing jaws.

ESSENTIAL CHARACTERS OF THE DENTITION

The dental characters of *Ornithorhynchus* fall, in a general way, into three categories: (1) those which are largely degenerate, (2) those which are progressive specializations correlated with function and acquired before the teeth lost their vital importance, and (3) those which are retained as basic characters of a more primitive and still more remote ancestral dentition. The evaluation of these dental characters as indications of affinity largely depends on the difficult task of distinguishing between these various categories.

It is safe to assume that numerical reduction, lack of true replacement, short period of use, and extreme variability are among the most recently acquired characters of this dentition, correlated with its decreased importance in the life of the animal, and of little or no value in determining its relationships. Together with some progressive adaptations, they indicate that this dental type is not, as sometimes stated, a primitive one, but very old, specialized, and degenerate.

The numerous minor cuspules and crenulations are probably not relics of ancestral structures. They are always present, apparently in analogy to the numerous other multicuspid mammalian dentitions adapted chiefly to crushing or to an omnivorous diet, but they seem in no case to be at all constant individually, and it seems unlikely that many or indeed any of them represent vestiges of definite ancestral cusps.

The following characters, variously emphasized by different authors, do not appear to me to be of definite value as indications of a remote ancestral condition:

1 The accessory cuspules are too inconstant to be of certain phylogenetic value as to either number or position. They do not prove or definitely indicate the original presence of other than the two main cusps of each tooth, and such ancestral cusps, if ever present, have lost their individuality.

2. A central basin with a surrounding cuspidate rim is neither present as such nor indicated. Both in the structure of each tooth and in occlusal relationships, the basins are related to the two main cusps.

3. The individual teeth are not constructed on a longitudinal plan aside from the two main cusps. The tooth row as a whole is, of course, longitudinal and the larger cusps follow more or less in a straight series, but there are no longitudinal valleys or crests, and the accessory cuspules are either simply marginal, whether longitudinal or transverse in their sequence, or, if not marginal, mere crenulations on transverse crests or quite irregular in arrangement.

The following, then, appear to be the more fixed characters of the monotreme dentition and those for which a theory of its origin and relationships must account:

1. The primary functional plan is of a single longitudinal row of a small number of cusps interlocking in a simple fashion.

2. Two of these cusps occur on each of the larger and more constant cheek teeth.

3. In all cases they tend to develop or to retain one or two transverse crests which may or may not terminate in variable small cuspules on the opposite side of the tooth.

4. The crown is further and essentially complicated by the presence of a broad and crenulated shelf flanking the main cusps on the outer side in the upper teeth and on the inner side in the lower teeth.

This pattern probably originated in one of the following three ways:

1. By the fusion of two, or possibly more, simple reptilian teeth. This would in itself leave open the question of relationship to the dentitions of higher mammals.
2. By differentiation, either independently or through one of the non-tuberculosectorial Mesozoic mammalian types (microcleptid, multituberculate, triconodont, symmetrodont).
3. By specialization and degeneration from a tuberculosectorial ancestry.

ORIGIN BY CONCRESCENCE

The theory of tooth complication by concrescence has been much discussed by Röse, Kükenthal, Pohle, Bolk, Schwalbe, Osborn, Gregory, and many others. It is a question open to conclusive proof by palæontological methods only, and so far as I know it has not been definitely supported by anyone thoroughly and broadly familiar with the evidence of fossil mammals and mammal-like reptiles. On the contrary, this evidence very strongly opposes the reality of concrescence, except in occasional abnormal cases of little or no phylogenetic significance. Unless the teeth of *Ornithorhynchus* can be shown in themselves to bear very strong evidence of concrescence, it is logically untenable that they originated by a process unimportant or absent in the development of the teeth of any other mammals or of the immediate ancestry of the Mammalia.

The only specific evidence for concrescence in *Ornithorhynchus* is the fact that the peculiar epithelial nodules mentioned on an earlier page, as demonstrated by Poulton and by Wilson and Hill, are more numerous than the definitive teeth.

This evidence seems to me insufficient basis for even a tentative theory for the following reasons:

1. The true nature of these nodules is still open to some doubt.
2. Although related to the definitive cusps in position, they do not exactly correspond to these in number.
3. Even if they should prove to represent extremely degenerate vestiges of a deciduous dentition, they would not be good evidence of concrescence, because (a) it would remain unproven that each deciduous tooth was actually represented by more than one nodule or that the

definitive teeth represented more than one deciduous tooth, and (b) if two or more nodules should actually represent one deciduous tooth, it would be much more probable that the nodules of each tooth are separated vestiges of a more complex but unified dental organ than that the dental organ was formed by a fusion of the elements represented by the nodules.[1]

The origin of the cheek teeth of *Ornithorhynchus* by concrescence is highly improbable.

ORIGIN FROM A TUBERCULOSECTORIAL TYPE

In the following points the dentition of *Ornithorhynchus* resembles the tuberculosectorial type:[2]

1. There is evidence of a regular crown pattern with a small number of cusps.
2. The upper and lower teeth are of similar pattern but reversed.
3. The outer side of the lower teeth and the inner side of the upper teeth are more prominent.
4. The teeth interlock and overlap in occlusion.

These are very general resemblances, quite insufficient to establish a probable theory without the further evidence of positive resemblance in pattern. Bearing in mind the occlusal relationships, the following are the only homologies which seem reasonably possible:

1. The anterior cusp of the upper teeth to be the protocone. It cannot be the paracone of a tooth of tuberculosectorial relationships which has lost or never developed its protocone, for it occludes with the median or posterior basin of the lower teeth.
2. The posterior upper cusp to be the hypocone.
3. The paracone and metacone to be lost or represented only by highly variable cuspules.
4. The anterior cusp of the first lower tooth to be the protoconid or in any event the sole surviving cusp of the trigonid as a whole.
5. The anterior cusp of the second lower tooth to be the protoconid, the paraconid and hypoconid either lost or represented by variable marginal cuspules.
6. The posterior cusp of each lower tooth to be the hypoconid, and here the sole constant talonid cusp.

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[1] Wood Jones' statement that the three definitive teeth eventually fuse might be construed as further evidence of origin by concrescence, but as such it would be equivocal as probably more analogous to occasional abnormal fusion in other mammals. Furthermore, it awaits confirmation and detailed study.

[2] Osborn (1907, p. 108) considered origin from tritubercular (or tuberculosectorial) teeth as a tenable but weakly supported hypothesis, citing the points here numbered 2 and 3.

These homologies are perhaps possible, but can hardly be seriously advanced as real in view of the following considerations:

1. The hypocone is generally absent in the most primitive tuberculosectorial teeth, and those that do have it are obviously too highly organized to be close to the monotreme stock.
2. These homologies are the only ones that make a mechanical approach to normal tuberculosectorial occlusion, but in fact the occlusion of *Ornithorhynchus* is unlike that of any tuberculosectorial derivative in detail.
3. Emphasis of the internal cusps of the upper, and external cusps of the lower, teeth with total reduction or loss of identity and stability of the opposite cusps nowhere occurs in known tuberculosectorial derivatives and is mechanically improbable.
4. In known tuberculosectorial derivatives the upper teeth are always wider than the lower teeth, while in *Ornithorhynchus* the reverse is the case.
5. Reversal of upper and lower tooth patterns is more or less of a theoretical abstraction in the Theria. It is not true of the true tuberculosectorial molars, and such cases as do approach *Ornithorhynchus* in degree of similarity are rare and very different mechanically and morphologically.
6. It is clear on general anatomical grounds that the monotremes separated from the Theria at a very early stage, and there is yet no evidence of the association of a true tuberculosectorial dentition with a bodily structure which could have given rise to the monotremes.
7. The earliest known relatives of the tuberculosectorial stock do not, so far as known, suggest the monotremes in any definite way, and their teeth are even less like those of *Ornithorhynchus* than are those of some later forms.

It is highly improbable that the teeth of *Ornithorhynchus* have passed through a tuberculosectorial stage.

POSSIBLE RELATIONSHIPS TO THE THERIA

Given this improbability of the derivation of the dentition of *Ornithorhynchus* from the tuberculosectorial type, two questions remain with respect to therian relationships:

1. Could the tuberculosectorial type be derived from one essentially like that of *Ornithorhynchus?*
2. Does the latter give any evidence of closer relationship to any other therian dental pattern?

These questions are involved in the consideration of this as a truly primitive dentition and in the whole question of the possible derivation of the Theria from the Prototheria.

As regards the first query, there is a total lack of evidence that such was the case, and a great deal of evidence that it was not. The difficulty of constructing a mechanically sound hypothesis on this basis is sufficiently clear from an examination of the essential characters of the *Ornithorhynchus* dentition as already set forth. Furthermore the pertinent palæontological evidence is in opposition. As already suggested, the earliest therians are just those which are least like *Ornithorhynchus* in any dental character. Most striking is the total dissimilarity of the known pantotherian dentitions, which are unlike those of *Ornithorhynchus*, with cusps which cannot be homologized with those of the latter on any reasonable basis.

Some students do not agree that the tuberculosectorial dentition is primitive for the Theria, although it does not seem that they have successfully explained the overwhelming evidence for this view. For them, it might be natural to consider the dentition of this very primitive living mammal as an alternative ancestral type for some or all of the Theria. No such theory appears to have been seriously advanced, however, and after careful study it does not seem possible to base one on the facts available. No therian molar pattern is close to that of *Ornithorhynchus*, and there is no evidence for the reality, in any case, of the profound changes required to convert one into the other.

DERIVATION FROM THE MICROCLEPTID TYPE

There are four non-tuberculosectorial mammalian molar tooth types known from the Mesozoic: the symmetrodont, the microcleptid, the multituberculate, and the triconodont. Except for the multituberculate, these are confined to the Triassic and Jurassic, and the absence of later forms clearly related either to these or to the monotremes before the Pleistocene makes only rather general speculation possible.

The symmetrodonts may be quickly dismissed. Their alternating trigons do not at all suggest the cheek teeth of *Ornithorhynchus*.[1]

The microcleptids are late Triassic forms known only from isolated teeth, and commonly, but with insufficient evidence, referred to the Multituberculata. Their teeth are very unlike those typical of the latter order, and they are to be considered separately. Comparison between the teeth of this group and those of *Ornithorhynchus* was instituted by Thomas (1889, pp. 130–131), who considered the resemblance the closest shown by the latter, and suggestive of relationship although not conclusive. The microcleptid molar consists of a longitudinal valley with a raised cuspidate rim, higher and with fewer cusps on one side than on the other. Compared at first hand, there is scarcely even a superficial resemblance to the *Ornithorhynchus* molar with its transverse valley and two widely separate large cusps. The evidence is too flimsy for serious consideration, at least until a great deal more is known about the microcleptids. Microcleptid teeth are much more like those of some recent bats than of *Ornithorhynchus*.

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[1] For figures of the teeth of these Mesozoic groups and discussion of their affinities, see Simpson, 1928 and 1929

DERIVATION FROM THE MULTITUBERCULATE TYPE

The first suggestion of affinities based on the discovery of the teeth of *Ornithorhynchus* was that of relationship to the Multituberculata (Cope, 1888), and this view has been repeated and expanded by numerous later workers. Here the evidence of the dentition is not equivocal. Far from supporting the derivation of the monotremes from the multituberculates, it interposes almost insuperable difficulties (see also Osborn, 1907, p. 107). The teeth are quite dissimilar, the cusps differing fundamentally in number, arrangement, form, and function. Multituberculate molars have five or more subequal cusps arranged in two or three straight longitudinal rows separated by straight grooves. These are subconical or, more commonly, more or less crescentic about a longitudinal axis and are wholly adapted for propalinal grinding. *Ornithorhynchus* molars are not really multicuspid but have only two main cusps separated by an irregular transverse groove or basin. The cusps are of irregular form and where subcrescentic it is on a transverse axis. They are adapted solely to crushing, interlocking in a way fundamentally unlike the Multituberculata. On the basis of the teeth alone it would be as reasonable to relate *Ornithorhynchus* to *Homo* as to the multituberculates. There is other and much stronger evidence of multituberculate-monotreme relationships which has been discussed and in a measure refuted elsewhere, but the teeth are certainly opposed to this view.

Abel's recent suggestion (1922, 1926) of the derivation of the monotremes from the multituberculates as evidenced by the relationships of *Desmostylus* to both groups is a special case demanding some notice Without regard to the relationship of *Desmostylus* to the multituberculates (which also seems to be non-existent), it seems impossible to accept the proposed relationship to *Ornithorhynchus* as real. Confining attention solely to the chief characters of the teeth, the following facts are pertinent:

1. The teeth of *Desmostylus* are extremely high-crowned; those of *Ornithorhynchus* are very low-crowned.
2. Those of *Desmostylus* have many subequal cusps; *Ornithorhynchus* has but two on each tooth.
3. The cusps of *Desmostylus* are closely appressed cylinders, arranged rather irregularly, with two or three in any transverse section; those of *Ornithorhynchus* are transversely elongate or subcrescentic and are in a single longitudinal series.
4. There are no cingula, basins, or open valleys in the *Desmostylus* molar, and the cusps do not interlock in occlusion; the *Ornithorhynchus* cheek teeth have unusually large cingula, open basins, and the cusps interlock.
5. The enamel of *Desmostylus* is very thick and of characteristic structure; that of *Ornithorhynchus* is thin and quite different in structure.

So far as the evidence of the dentition is concerned, it is strongly opposed to Abel's theory.

DERIVATION FROM THE TRICONODONT TYPE

Except in a previous study by the present writer (1928), the triconodont molar does not appear to have been considered in this connection. The following are points of resemblance between the triconodonts and *Ornithorhynchus:*

1. Both have an unusually small number of main cusps.
2. In both, these are arranged in one longitudinal series.
3. In both, the cusps of opposing teeth alternate and to some degree interlock in occlusion.
4. In both there is a crenulated cingulum, internal on the lower molars and external on the uppers.
5. In both, the jaw movement is mainly or wholly orthal.

On the other hand, they have the following chief distinctions:

1. Triconodonts have three main cusps on each molar. *Ornithorhynchus* has but two.
2. Triconodont teeth are strongly adapted to shearing, not at all to crushing. In *Ornithorhynchus* the reverse is true.
3. The triconodont cingula are narrow and there is an internal upper cingulum. Those of *Ornithorhynchus* are very wide and there is no internal upper cingulum.

4. In triconodonts the lower cusps shear up steep valleys between the upper cusps and come to rest with their apices more lingual than those of the latter. In *Ornithorhynchus* the lower cusps pound directly into broader and more horizontal valleys and their apices are more buccal than those of the upper cusps.

The resemblance is certainly not very striking, but is at least as close as that between *Ornithorhynchus* and any mammals other than triconodonts. The relationship would have to be proven by the discovery of other and closer points of comparison or of intermediate forms. The gap is so great that there can now be no presumption of a real relationship, but there seems no reason to consider it impossible.

INDEPENDENT DERIVATION FROM A REPTILIAN TYPE

It has been emphasized that the teeth of *Ornithorhynchus* are not like those of any other known animal in form. While the vast palæontological blank makes it inadvisable to brand any particular theory as quite impossible, it has been shown that derivation from any known mammalian type is improbable. It has been found impossible to propose definite homologies with the teeth of any marsupial or placental, and still more difficult to make any close comparison with the multituberculates, although these have so often been compared. A vague resemblance to the triconodonts may eventually prove to be significant but at present is not trustworthy. The evidence, not wholly negative, thus tends to emphasize the sharp separation from all other mammals seen throughout the whole organization of *Ornithorhynchus*. For what it is worth, it tends to remove the group from any central position in therian phylogeny, to emphasize the rather widespread opinion that *Ornithorhynchus* is not merely a more primitive therian or even one specialized on the general primitive therian basis, but something quite distinct.

There is nothing like this dentition among mammal-like reptiles. They do exhibit in their variety of tooth forms a potentiality for developing such a pattern, even though the true ancestor is doubtless unknown, and a simple (but absolutely hypothetical) origin might be assigned to such teeth by the action of processes which did occur in the theromorphs. This would involve primary longitudinal differentiation into two main cusps, and transverse differentiation through the upgrowth of cingula, as suggested in *Diademodon* or *Pachygeneleus*, on opposite sides of upper and lower teeth.

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AMERICAN MUSEUM NOVITATES

Number 391 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Dec. 7, 1929

59.57, 72 D (66.6)

NEW DOLICHOPIDÆ FROM LIBERIA AND THE BELGIAN CONGO

BY C. H. CURRAN

In his revision of the Dolichopidæ of Africa, published in 1923, Becker lists one hundred and fifty-seven species, a large number of which are Palæarctic in distribution. Since that time eighty species have been described from the Æthiopian region and a few from Egypt. These, together with the eight species herein described, bring the total species known to occur in Africa to slightly more than two hundred and fifty.

During a year's sojourn in Africa in 1926–27, Dr. Joseph Bequaert made rather extensive collections of Diptera in Liberia, Uganda, and the Belgian Congo. The new species described in the present paper form part of this collection and through the generosity of the collector the types are deposited in The American Museum of Natural History.

Sciapus lenga, new species

Shining green, legs yellow; wings hyaline, in the male faintly clouded on the apical half in front. In the male the fourth vein is produced backwards at the usual place of the angulation in the shape of U; in the female the venation is normal. Length, 3 to 4 mm.

MALE.—Head green; face and front yellowish white pollinose, the front in some views appearing almost bare, violaceous in the middle; upper section of the face violaceous, wider than long; occiput with yellowish pollen, sparsely yellow pilose below. Face narrower than either eye from frontal view, very slightly narrowing below, the front slightly widening to the vertex. Palpi black, long and porrect, black-haired above, fringed on either side with abundant, long yellow pile; proboscis yellowish. Antennæ black or brown, the first segment obscurely reddish below; third segment brown, rounded apically; arista short.

Mesonotum from anterior view appearing dull brown, from dorsal view bright green on the posterior two-thirds; notopleura white pollinose. Pleura mostly brownish, the posterior half white pollinose, the anterior half with brown pollen and some green reflection. Five dorsocentrals; two pairs of very weak acrosticals.

Legs yellowish, the tarsi brown, becoming yellow basally; middle and posterior coxæ brown at least on the outer surface. Coxæ with yellow hair, the anterior pair with three weak bristles apically. Legs black-haired, the femora with rather inconspicuous yellow hair below; no bristles except some inconspicuous yellow ones on the posterior tibiæ. Tarsi long and slender, the posterior pair with the apical two segments broadened, the fourth triangular, the fifth broader than long and transversely concave above; fifth segment of anterior four tarsi conspicuously broadened.

Wings hyaline with indications of a brownish cloud in front on the apical third or more. (The specimen appears to be somewhat teneral and there may normally be a brown cloud.) The fourth vein is curved backwards U-shaped well beyond the posterior cross-vein and joins the third vein just before the apex of the wing; posterior cross-vein not oblique, bowed outwards. Squamæ luteous, with black border and fringe. Halteres yellow.

Abdomen shining green, the venter yellowish; hair black, bristles fairly weak, sides and venter pale-haired. Genitalia brown, small, the posterior lamellæ small, broad, suddenly narrowed at their apical third.

FEMALE.—The female is unusual in that the front is much less concave than in the male and would be placed in the genus *Leptorhethum* Aldrich. Face narrower, not half as wide as eye; palpi much smaller but with similar arrangement of the black hair and pale pile; mesonotum mostly violaceous and more extensively brown pollinose. Coxæ wholly yellow; tarsi yellow with the apical two segments black, the apical segment of each pair broadened as in the front legs of the male. Wings hyaline, with normal venation, the fourth vein with an appendage at the bend, the apical cell open. Abdomen grayish pollinose laterally.

TYPES.—Holotype, male, Lengatown, Liberia, August 15, 1926; allotype, female, Du River, Camp No. 3, Liberia, (J. Bequaert).

This species is most nearly related to *flabellifer* Becker but the anterior coxæ are not black on the basal half and the posterior lamellæ of the male are not long and thread-like.

It seems strange that there should be the difference in the shape of the front of the male and female and it may be that they represent different species. The enlargement of the apical tarsal segment in the female is a very unusual character and it is largely on this account that the two sexes are placed together. The difference in wing venation is to be expected; in the female the color of the pollen, palpi, etc., is quite in keeping with the male and it is difficult to believe that two genera are represented.

The genus *Leptorhethum* Aldrich is represented in Africa by one species described by Becker. This is a yellowish species known only from a single female. Is this a case similar to the present, where the two sexes show different head characters?

Chrysosoma du, new species

Related to *collarti* Curran but distinguished by several characters. In *callarti* the arista bears the longest hairs on the thin section preceding the very long, flattened lamella: in *du* the longest hairs are on the much shorter lamella. The first segment of the anterior tarsus of *collarti* is broad on its whole length although tapering apically and ciliate posteroventrally: in *du* this segment is narrow on almost its apical half and not ciliate on its basal half. Of the three African species with lamellate arista this is the only one with yellowish squamal cilia although it is possible that this character is apparent because the specimen is not fully mature. If this is the case it will trace to *collarti* Curran in my key (1927, Rev. Zool. Afr., XV, p. 242); in the section with pale squamal cilia it is distinguished from all others by the lamellate arista. Length, about 8 mm.

MALE.—Head green, cinereous pollinose, the front bare and shining. Occipital cilia limited to upper half of the head, black; occipital pile whitish. Proboscis and palpi reddish yellow, the latter yellow-haired and with one black bristle. Antennæ yellow, the arista blackish, not separated from the third segment; the lamella is narrow, about three times as long as the basal two antennal segments, moderately long ciliate on both sides, the cilia on the apical fourth shorter, finer and more abundant, the longer cilia extending along the rounded portion of the arista for a distance greater than the length of the lamella, although on one side they are discontinued considerably before than on the other and they decrease in length towards the base of the arista.

Mesonotum bright green, the humeri and lateral margins narrowly yellowish; a median vitta violaceous; between the inner end of the humeri and the suture a dull brownish stripe; hypopleura yellowish; metasternum brown; propleural hair yellowish.

Legs yellow, the middle coxæ with a large brown spot on the outer side; posterior four tarsi brownish, becoming pale basally, the apical segment of the anterior tarsi also brown. Coxæ and under surface of the femora yellow-haired, the anterior coxæ with a row of five stout, yellow bristles on the outer edge in front and with a row of short, black bristles on the inner edge; on the anterior four femora the hair forms a sparsely ciliate row below. Middle femora on the apical fourth with a row of five bristles on lower anterior surface and three or four shorter ones behind, the posterior femora with about five anteroventral bristles apically, only the apical one of which is strong. Anterior tibiæ with four bristles, one small one on either side of the upper surface near the base, a small posteroventral one a little before the middle and a large, fine one at the apical third; in addition there is the usual preapical dorsal bristle and a longer, curved posterior one; at the apex beneath are two spinous bristles, the posterior one thick and blunt at the apex, the anterior one slender and curved backward so as to pass across the apex of the thickened basal section of the tarsus. Posterior tibiæ with a row of six short anteroventral and posterodorsal bristles and two anterodorsals. Basal segment of the anterior tarsi broad on basal half and flattened below, the apical half conave beneath and bearing abundant short, fine pile; second segment gently concave above, on the lower edge with dense white pubescence; third segment a little more than half as long as the second, fourth a little shorter than the second, the fifth short. Middle tarsi simple, apical two segments of posterior tarsi noticeably broadened.

Wings cinereous hyaline: they do not appear to be fully developed. Probably in mature specimens they are clouded in front and along the veins. Posterior crossvein oblique, moderately curved. Squamæ yellow, with brown border and brownish-yellow cilia, the cilia perhaps mostly black in some specimens. Halteres yellow.

Abdomen green, the segments with broad opaque black fasciæ basally, the sides very broadly whitish pollinose on the green portions; each segment with long marginal bristles. Genitalia brownish, of the general type of *collarti* but the outer lamellæ longer, less hairy and deep black. Abdominal hair black, yellowish on the first segment and sides of the second.

HOLOTYPE.—Male, Du River, Camp No. 3, Liberia, (J. Bequaert).

Chrysosoma liberia, new species

Wings brown with two pale spots near the middle; antennæ reddish. Most nearly related to *albilimbatus* Bigot, to which it traces in my key, but at once distinguished by the green front. Length, 8 mm.

MALE.—Head green, somewhat dull brassy, the occiput and sides of the face thinly yellowish pollinose; middle of front and lower section of face with slight bluish reflection. Occipital pile yellowish. Palpi brown, with yellow hair and two or three black bristles. Antennæ reddish, the upper edge of the third segment and the arista black.

Thorax green, the mesonotum brassy, a large rectangular spot covering each humerus and extending narrowly blackward along the line of the dorsocentral bristles and the inner edge of the notopleura opaque brownish black; posterior half, sides irregularly and the scutellum dorsally, violaceous; pleura moderately cinereous white pollinose. Propleural pile whitish.

Legs reddish; coxæ blackish, yellow-haired, the front pair with three or four black bristles apically, the middle pair with black hair and bristles along the outer edge and apically. Trochanters and very narrow bases of the posterior four femora brown; the posterior femora obscurely brown at the apex; posterior tibiæ yellowish brown, the anterior four broadly brown apically; tarsi wholly blackish. Anterior tibiæ with two strong anterodorsal bristles and two very weak posterior ones, their tarsi simple, the basal segment much longer than the remaining ones combined. Middle tibiæ with a row of ten long, slender posterodorsal bristles, six anterior bristles and two ventral ones; basal segment of the middle tarsi with a row of seven long, slender posterodorsal bristles and six short, subappressed anterior ones, the remaining segments simple; posterior tibiæ with a row of about eight dorsal, four anterior and five posteroventral, short bristles, their tarsi simple.

Wings brown, with the posterior border rather grayish; a narrow yellowish-tinged triangle extends backward from the costa immediately beyond the end of the first vein to the anterior third of the discal cell and immediately beyond the posterior section of the large cross-vein is a grayish-white spot. Bend of fourth vein with a long, strong appendage, posterior cross-vein strongly S-shaped. Squamæ and halteres brown, the former black ciliate.

Abdomen green, the apices of the segments narrowly black, the sides rather dull, the apical segment wholly dark; each segment with an apical row of bristles; hair yellowish on sides of first segment and on bases of basal two sternites. Genitalia blackish, similar to *albilimbatus* Bigot but without the median angulation to the outer lamellæ and with more abundant hair apically.

HOLOTYPE.—Male, Du River, Camp No. 3, Liberia, (J. Bequaert).

KALOCHETA Becker

This genus is most nearly related to *Chrysosoma* Guérin but is distinguished by the peculiar development of the arista in both sexes. The arista appears to form a fourth segment of the antennæ, being broad and strap-like for half its length or more, the apical section forming a slender style.

The genus *Kalocheta* was established by Becker in 1919 (Mitt. Zool. Mus. Berlin, XII, p. 41) for a new species from Cameroon. I have seen several specimens from the Belgian Congo. Owing to the small amount of collecting in the region it is not possible to form any definite conclusions regarding the extent of the distribution of the species. Dr. Bequaert has secured an excellent series of an undescribed species in Liberia. The two species may be readily separated as follows.

a. Hair-like part of arista not half as long as strap-like portion; median brown band of wing with the concavity on the outer edge . . . *passiva* Becker.

b. Hair-like part of arista as long as strap-like portion; median brown fascia extending broadly along the fourth vein towards the base of the wing instead of extending to the fifth vein . . . . *liberia*, n. sp.

Kalocheta liberia, new species

Wings brown and yellow with the posterior border grayish. Length, 6 to 7 mm.

MALE.—Front violaceous, its sides, face and occiput green, the face thinly whitish pollinose; occiput with cinereous pollen. Occipital pile moderately abundant, yellow, a few black hairs on either side of the front. Palpi and proboscis reddish, the former with black hair. Antennæ red, the apical half of the third segment and the arista black. The strap-like part of the arista is twice as long as the length of the head, the whole arista four times as long as length of head.

Thorax green, the lateral margins of the mesonotum broadly violaceous, the posterior border, the hypopleura and scutellum, sometimes violaceous. A broad cupreous or bronze vitta extends along each acrostical row. Propleural hair black. Scutellum with two bristles.

Legs yellowish, tarsi brown, the first segment of the middle pair becoming yellow basally. Anterior coxæ yellow, with yellow hair and two black apical bristles; posterior four coxæ blackish, cinereous pollinose, black-haired. Anterior four femora with sparse, fine bristles on basal two-thirds of either lower edge, the basal bristles longest; posterior femora with three or four fine bristles on basal half of anteroventral surface. Anterior tibiæ with two short dorsal bristles; middle tibiæ with two posteroventral bristles, three anterior bristles and one anterodorsal bristle, the latter situated near the base of the tibiæ and a row of seven dorsal bristles, the basal three of which are successively shorter; posterior tibiæ with about seven short dorsal and ventral bristles on basal three-fourths and three posterior bristles. Anterior and posterior tarsi simple; middle tarsi with a row of six long, slender dorsal bristles on the basal segment.

Wings brown, the posterior border cinereous, a broad stripe in front, interrupted by a brown spot at its apical fifth and the discal cell mostly hyaline; auxilliary cell brown except for a large, almost hyaline spot at its middle; another almost hyaline spot just beyond the posterior third of the discal cell. Squamæ brownish, with black cilia. Knob of halteres yellowish.

Abdomen green, the basal segments sometimes largely violaceous dorsally; apices of segments broadly dull black. Genitalia blackish.

FEMALE.—Differs sexually; the middle tibiæ bear five or six dorsal bristles which are much shorter and stouter than in the male, the first segment of the middle tarsi lacks dorsal bristles and the bristles on the posterior tibiæ are a little stouter and longer.

TYPES.—Ten males and five females, Camp No. 3, Du River, Liberia, collected by Dr. J. Bequaert. The holotype male and allotype female are in The American Museum of Natural History. Paratypes in the Musée du Congo Belge and collection of Dr. Bequaert.

PARACLIUS Bigot

There are at least three species of *Paraclius* occurring in West Africa but up to the present time the only described forms are from South Africa. The following key will separate the species.

1. Antennæ wholly black. . . . . .2.
   Basal two antennal segments reddish. . . . . *bequaerti*, n. sp.
2. Posterior tibiæ with narrow black apex, the posterior tarsi wholly black.
   afra Curran.
   Posterior tibiæ wholly yellowish, the basal segment of their tarsi yellowish on more than the basal half. . . . . *funditor* Curran.

Paraclius bequaerti, new species

Front green, face white, legs yellow, posterior tarsi wholly black. Length, 6 mm.

FEMALE.—Face white, narrow, gently narrowing to the lower edge; front green, in some lights white pollinose on lower half, orbital cilia black on upper half, white on lower half; palpi and proboscis reddish, with black hairs. Antennæ reddish, the third segment, except its narrow base, and the arista, blackish, the arista long pubescent.

Thorax black and green; in front with an interrupted band of white pollen which covers the notopleura laterally and is best seen from posterior view; beneath the pollen the color is bright green and the posterior half of the mesonotum is of the same color. In front of the anterior green band the color is subopaque black and there is a similar broad band of black immediately behind; in front of the scutellum is a narrow, black triangle and the scutellum itself is opaque blackish except on its narrow free border. Pleura rather thinly white pollinose. Hair and bristles of thorax black.

Anterior coxæ yellow; all the coxæ thinly white pollinose and bearing black hair. Legs yellow; posterior femora with an apical black spot above; posterior tarsi wholly black, the middle pair black from the apical fourth of the basal segment, the anterior tarsi yellow but appearing brown on account of the black hair; posterior four femora with one preapical bristle and an anteroventral row of black bristles; tibiæ with the usual stout bristles, their dorsal surfaces whitish yellow.

Wings strongly tinged with brown. Halteres and squamæ yellow, the latter black ciliate.

Abdomen opaque black, the second to fifth segments each with a broad, moderately interrupted fascia of bright green which does not reach the lateral margins, the outer half of each transverse spot densely white pollinose, the inner half appearing thickly pollinose in most views. First segment with a transverse, green spot on either side, which also appears pollinose in some views. Venter shining black. Hair wholly black.

TYPES.—Eight females from Bakratown, Liberia, October, 1926, and one female from Saub Koko, Liberia, September, 1926, all collected by Dr. J. Bequaert. Holotype, from Bakratown, in American Museum of Natural History. Paratypes in collections of Musée du Congo Belge and Dr. Bequaert.

TACHYTRECHUS Walker

Of the eleven species of *Tachytrechus* recorded from Africa five are confined to the Palæarctic region. One species, *pteropodus* Schiner, originally described from South America and recorded by Becker from South Africa should probably be removed from the list of African Dolichopidæ. The following key separates the African species known to me.

1. Legs extensively reddish or yellowish . . . . 2.
   Legs wholly black . . . . *imperator* Curran.
2. Femora reddish yellow, at most the narrow bases black . . . . 3.
   Femora black on basal half; antennæ black except just below the apex of the first segment . . . . *bracteatus* Wiedemann.
3. Basal two antennal segments reddish yellow . . . . 4.
   Antennæ black . . . . *absconeus* Wiedemann.
4. Third antennal segment more than half reddish . . . . 5.
   Third antennal segment wholly black or nearly so . . . . 6.
5. Posterior tarsi wholly black (Egypt) . . . . *salinarius* Becker.
   Basal segment of posterior tarsus yellowish on basal three-fourths . . *liberia*, n. sp.
6. Propleura with coarse black hair . . . . *alternatus* Curran.
   Propleura with yellowish pile . . . . *capensis* Curran.

Tachytrechus liberia, new species

Readily distinguished from all the African species but *salinarius* Becker by the reddish yellow third antennal segment. The mostly yellowish basal segment of the posterior tarsi, non-vittate mesonotum and ochreous face readily separate it from *salinarius*. Length, 5.25 to 5.75 mm.

MALE.—Face ochreous or golden yellow; front green, in some lights white pollinose. Occipital cilia fine, the upper ones black, lower ones yellow. Palpi black, black-haired. Antennæ reddish yellow above, whitish yellow on lower half; third segment small, suborbicular, brown on upper third; arista brown.

Thorax green; mesonotum and scutellum grayish brown or grayish yellow pollinose, more densely so along the middle line, the broad sides and an equally broad vitta along the upper border of the pleura brownish black, subopaque. Scutellum with a pair of strong bristles and pair of short, hair-like ones. Propleura with a few black hairs or bristles. Pleura cinereous pollinose.

Legs reddish yellow; posterior four coxæ brown on outer surface, white pollinose; anterior coxæ with some inconspicuous black hairs on inner part of anterior surface, otherwise almost bare except for the usual row of apical bristles. Posterior femora somewhat brown at apex except below; apex of posterior tibiæ brown, of the middle pair obscurely so; tarsi blackish from the apical third or fourth of the basal segment. Legs quite simple in structure; middle femora with two small bristles on anterior surface apically, the posterior femora with three anterodorsal bristles on the apical half.

Wings brown in front becoming gray behind, the posterior cross-vein slightly clouded. Squamæ and their cilia black. Knob of halteres reddish brown.

Abdomen dark green, the sides broadly bronzed, the apices of the segments broadly blackish; each segment bears on either side a large white pollinose spot, those on the second and third segments triangular, small, on the first segment quite small. Genitalia large, the lamellæ of moderate size, brown, sub-triangular with broadly rounded corners, the hair fine and black, yellowish basally, the marginal fringe not strongly developed.

FEMALE.—Differs only sexually. The median vitta of the mesonotum may be a little more brown.

TYPES.—Five specimens of each sex from Moala, Liberia, October 31, 1926 and one female, Bakratown, Liberia, October, 1926, (J. Bequaert). Holotype male and allotype female, from Moala, in American Museum of Natural History. Paratypes in collections of Musée du Congo Belge and Dr. Bequaert.

SYMPYCNUS Loew

Thirteen species of *Sympycnus* are recorded from Africa, three of them from the Palæarctic region. The known males of the species occurring in the Ethiopian region are separable as follows.

1. Apical one and one-half segments of the front tarsus white, silvery pilose. *nectarophagus* Curran.
   Anterior tarsus without white apical segments........................ ....2.
2. Basal segment of front tarsus produced as a long finger-like lobe which is three-fourths as long as the second tarsal segment .... *munroi* Curran.
   Basal segment of anterior tarsus not lobed ....3.
3. Fourth segment of posterior tarsus at least one-fourth longer than the third. . .4.
   Fourth segment of posterior tarsus shorter than third or of equal length and never modified...................... ....7.
4. Basal three segments of posterior tarsi broadened and densely short-haired. *caffer* Loew.
   Basal two segments of posterior tarsi simple...........................5.
5. Third and fourth segments of posterior tarsi oval, incrassate. . *globulipes*[1] Becker.
   Third and fourth segments only a little enlarged, not oval..................6.
6. Third segment of posterior tarsus with thorn-like apical spine on posterior surface; pleura green in ground color.............. *congensis*, n. sp.
   Third segment of posterior tarsus ciliate like the fourth; pleura brown with gray pollen...................... .... *setosipes*[1] Speiser.
7. Abdomen with yellow spots or bands or almost wholly yellowish. ....8.
   Abdomen black, sometimes yellowish brown basally............ ....9.
8. Pleura black............. .... *placidus* Curran.
   Pleura yellow. . . . . . . *du*, n. sp.

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[1] See footnote on page 9

9. Posterior tarsi simple 10.
Third and fourth segments of posterior tarsi slightly enlarged and ciliate posteriorly with short, fine, bristle-like hair . *setosipes*[1] Speiser.
10. Genitalia of male small, hidden; large corss-vein situated before the middle of the wing *simplex* Curran.
Genitalia rather large; large cross-vein situated well beyond the middle of the wing *niger* Curran.

Sympycnus congensis, new species

Related to *caffer* Loew but the basal two segments of the posterior tarsi are simple and the second segment is almost three times as long as the third; in *caffer* the second segment is less than twice as long as the third. The insect is larger, more slender and has relatively longer legs than *caffer*. Length, 3.75 mm.

MALE.—Eyes contiguous for about half the length of the face; face and front cinereous yellow pollinose, the front with brownish tinge. Occiput gray pollinose; occipital cilia black on upper half; hair yellow. Mouth-parts brown. Antennæ blackish; third segment triangular.

Thorax green; mesonotum and scutellum cinereous brown pollinose; pleura with cinereous pollen; fine hairs above the front coxæ and on the propleura whitish.

Legs yellow; posterior four coxæ brown, the anterior pair with yellow hair; posterior femora brownish above except basally, the posterior tibiæ becoming yellowish brown apically, their tarsi blackish brown; anterior four tarsi black from the apical fifth of the basal segment. Anterior legs simple; middle tibiæ with four anterodorsal, three posterodorsal, and one anteroventral bristle; posterior tibiæ with five posterodorsal three anterodorsal and a row of five or six fine, not very conspicuous ventral bristles, the posterior femora with two preapical bristles, one situated anterodorsally the other anteroventrally. Basal two segments of posterior tarsi long, of about equal length, the third and fourth somewhat swollen, the fourth ciliate posterodorsally with short bristle-like hairs and highly polished posteriorly, the third with a strong, gently curved posterodorsal bristle at the apex and more conspicuous pile than the basal segments; fourth segment twice as long as the third.

Wings brownish. Halteres and squamæ yellow, the latter with brown border and yellow cilia.

Abdomen bronze-black, each segment with a large, thinly pale pollinose green triangle on either side. Genitalia shining brown, the outer lamellæ small, subtriangular, brownish yellow.

HOLOTYPE.—Male, Butshuru, Eastern Congo, September, 1914, (J. Bequaert).

This species agrees well with the description of *setosipes* Speiser except in a few details. The length of *setosipes* is 2.25 mm., the pleura are black and the third tarsal segment is said to be ciliate like the fourth on the inner (posterior) surface. Speiser could hardly have overlooked the bristle on the third segment and this segment is not ciliate in *con-*

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[1] These species are included from description only Speiser does not mention the lengths of the tarsal segments The male of *aristalis* Curran is not known, it seems probable that this species and *niger* Curran belong to another genus.

gensis. Moreover, the great difference in size clearly indicates the distinctness of the species in this genus, even when allowance is made for omissions of details.

Sympycnus du, new species

A yellowish species with metallic green reflections on the mesonotum and diffuse brownish abdominal incisures. Length, 4.5 mm.

MALE.—Face linear, white; front metallic violaceous with the sides very narrowly white pollinose. Occiput blackish green, grayish pollinose; occipital cilia black, the hair yellowish. Proboscis brownish red; palpi brownish with yellow border and obscure pale hairs. Antennæ black, the third segment rather reddish, evidently short but apparently not perfect in the specimen; arista brown.

Thorax rusty reddish yellow, the mesonotum on the posterior three-fourths with metallic green reflections except laterally; on either side immediately behind the notopleura an oval, opaque black spot. Scutellum, with the exception of the sides, violaceous.

Legs simple, yellowish, the apical segment of the tarsi brown; anterior pulvilli large. Anterior and posterior femora with one preapical bristle posteriorly, the middle pair with two, the posterior four femora each with a single preapical in front; middle and hind tibiæ with three dorsal bristles; the posterior pair also with a row of erect, short bristle-like hairs dorsally and with four to six fine ventral bristles. Basal segment of posterior tarsus much shorter than the following segment.

Wings lightly cinereous. Large cross-vein beyond middle of wing. Squamæ yellow with brown border and fringe. Halteres missing.

Abdominal incisures brownish, the second segment also with a sub-basal transverse brownish fascia, the basal and apical incisures not at all brown. Hair black, Genitalia small, yellow. The abdomen is shining rusty yellowish, pale below.

HOLOTYPE.—Male, Camp No. 3, Du River, Liberia, (J. Bequaert), in American Museum of Natural History.

AMERICAN MUSEUM NOVITATES

Number 392

Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

Dec. 9, 1929

59 51,7:07 (74 7)

NEW SPECIES OF POLYCHÆTOUS ANNELIDS IN THE COLLECTIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, FROM PORTO RICO, FLORIDA, LOWER CALIFORNIA, AND BRITISH SOMALILAND

A. L. TREADWELL

The collections of The American Museum of Natural History contain a number of polychætous annelids, collected at various times and at various localities. In a study of these annelids a number of new species were discovered. Their descriptions follow.

Nereidæ

Ceratonereis singularis, new species

Figures 1 to 8

Small annelids averaging 15 mm. in length, with a prostomial width of not over 1 mm. The coloration (in preserved material) is variable, some being marked dorsally by a dense brown pigment, others nearly colorless. The general plan of pigment-distribution is that at the anterior end of each somite are two transverse dorsal bands of brown pigment, the posterior band being the wider. Sometimes it is spread over a larger area of the surface and in that case the coloration is less dense. In some individuals this coloration holds through as many as 16 somites, while in others, after the first 3 or 4, the posterior band extends until it becomes confluent with the anterior and in this case the darker region is at the posterior part of the somite. The parapodia are unpigmented except that sometimes a line of pigment extends out over the parapodial surface. In still other cases, especially through and behind the median region the pigment divides into 4 or 5 narrower bands, sometimes showing an especially prominent spot on the median dorsal surface. At the extreme posterior end of the body where the somites are closely crowded together the coloration is often more intense than anywhere else. On the prostomium is an oval, transversely arranged brown patch between the posterior eyes, and another patch is located just where the anterior end of the prostomium divides to form the cirrophores for the antennæ. There may be a similar patch on the base of each palp. The above description applies to over 100 specimens collected by C. H. Townsend at Carmen Island, Lower California. More than 100 were taken at San José Island in the same region, and these, in general, are much lighter in color. Where color appeared it was distributed essentially as above.

The prostomial length (Fig. 1) is about equal to its breadth, but its anterior margin has a deep incision, each part lateral to this incision forming a cylindrical cirrophore for the antenna. The eyes are very large and black, with prominent lenses.

Those of the same side are almost in contact and those of the anterior pair are slightly farther apart than the posterior ones. The lenses of the anterior pair point anterolaterally, those of the posterior a little lateral of dorsally. The palps are about twice as long as the prostomium and are cylindrical with little narrowing toward the ends. The terminal joint is about one-quarter as long as the basal, the latter often bent and twisted so as to give the impression of a joint near its middle. Of the paragnaths, I is missing; II, a crescent-shaped double row; III, a circular area of about 15; IV, small rounded area of about 9. No proboscis is fully extended and the arrangement of the other paragnaths is not clear. The maxillæ are light brown in color with deeper margins. Each has 5 or 6 teeth in addition to the terminal one.

In most cases the tentacular cirri are lost and in an examination of over 150 individuals I was able to find only the two basal ones remaining. That of the anterior pair is about as long as the antenna and a trifle stouter than the one of the second pair which extends to somite 7. The antennæ offer the most remarkable feature of the head region. They are nearly twice as long as the prostomium, the length being accentuated by the cirrophores formed by the division of the prostomium. Their form is lanceolate with the width of their bases equal to that of the cirrophores.

In the first parapodium the dorsal cirrus (Fig. 2) is inserted into a notch of the notopodium which is continued beyond this point as a cirrus-like process that is rather more slender than the dorsal cirrus. The neuropodium has a slender postsetal lobe into which the acicula extends, and a much shorter presetal one. Ventral to this it is continued as a tapering, cylindrical process extending a short distance beyond the setal lobe. The ventral cirrus is very long, longer than the neuropodium. The somites following the first are larger than it, and separation of the parapodium into neuropodia and notopodia soon occurs (Fig. 3, fifth parapodium). The dorsal cirrus is slender and long, extending far beyond the end of the parapodium. The notopodium has two conical lobes with an acicula coming to the surface between them. The neuropodium has a slender postsetal-lobe, and rounded presetal lobes with an acicula. The ventral lobe of the neuropodium is relatively much smaller than in the first parapodium and is about as long as the presetal lobe. The ventral cirrus is extremely slender.

In some specimens this type of parapodium is continued for a considerable distance along the body while in others a change takes place after the sixteenth somite, this change being associated with the assumption of the epitokal phase. The first change to be noticed is the appearance of the setæ with broad paddle-shaped terminal joints (Fig. 8), which occur in parapodia which have not begun to modify and are not markedly different from that shown in Fig. 3. In others, which I interpret as a later stage, the parapodia are very much changed (Fig. 4). The conical notopodial lobe is much smaller than the setal portion and dorsal to the base of the dorsal cirrus is a small rounded lobe. Two similar but larger lobes lie, one on either side, at the base of the ventral cirrus. The setal lobes are equal to one another in length and are very broad, the notopodial lobe having a finger-shaped process on its ventral margin, and the neuropodium a conical lobe on its lower margin. Posterior to these is a broad rounder thin expansion covering the gap between the two halves of the parapodium.

At the posterior part of the body is a region of about 25 somites in which the parapodia do not show these epitokal modifications. One of these from the anterior end of the series is shown in Fig. 5. The dorsal cirrus is very prominent, the dorsal notopodial lobe appearing as merely a conical protrusion attached to the cirrus near its base. The setal lobes are acutely conical and the ventral neuropodial lobe is slender. The ventral cirrus is about the same size as in the earlier somites. In most cases, I was unable to find any setæ in these parapodia, but in one instance there were two kinds represented. One was the broad paddle-shaped ones found in the epitokal condition, the other had a camerated shaft and very short terminal joint. The latter was hooked at the end and had a row of fine spines along one margin.

In the first parapodium are two kinds of setæ. They both have camerated shafts, but differ in the form of the terminal joint. In one, this joint is very long and slender and very sharply pointed (Fig. 6). A row of delicate spines occurs along one border. In the other the terminal joint has the marginal row of spines but it is shorter than in the first mentioned, is somewhat broader, and its apex is a blunt hook instead of a sharp point (Fig. 7). In the first parapodium the setæ protrude above and below the acicula, and there is no sharp division into two groups. In later parapodia, where this division appears, the setæ with the longer terminal joints make up all of the notopodial tuft and a part of the neuropodial, those with the hooked terminal joint are limited to the notopodium. In these somites, the setæ are essentially of the same form as in the first. In the epitokal region they all have the paddle-shaped terminal joint shown in Fig. 8.

There are about 200 specimens in the collection marked "Carmen Id. E. side electric light"; "Carmen Id. S. E. side electric light"; and "San José Id.."

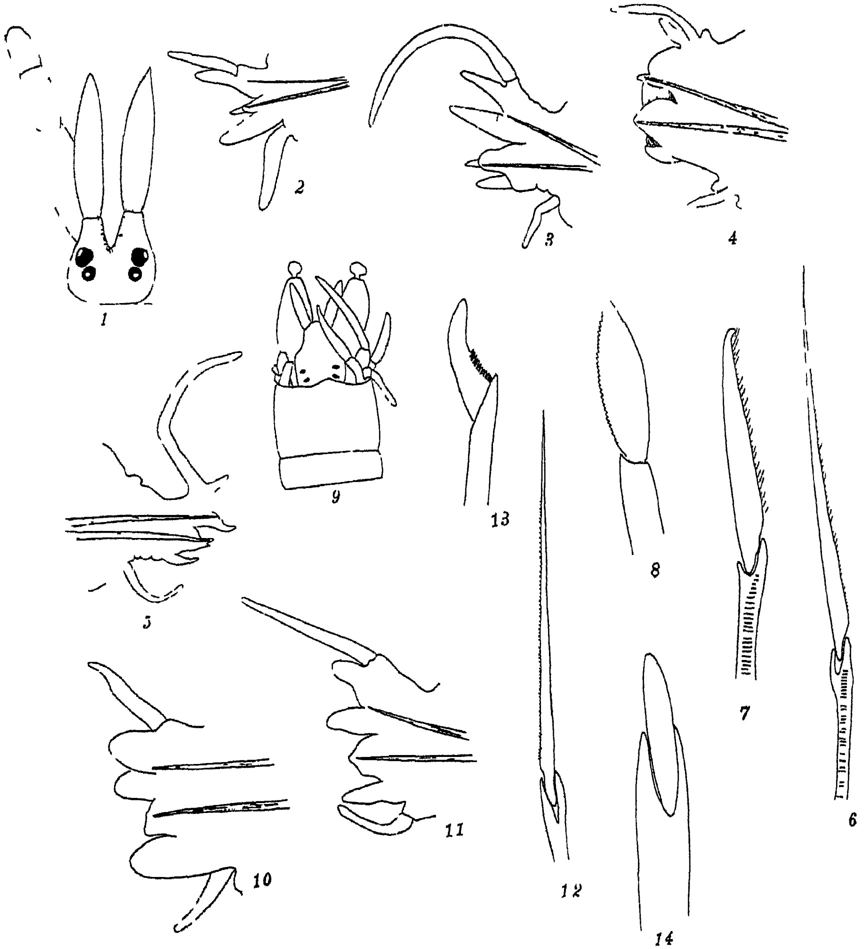
The type is from San José Island, Lower California, and is Cat. No. 1986 in The American Museum of Natural History.

Nereis brevicirrata, new species

Figures 9 to 14

The type specimen is 120 mm. long, with a peristomial breadth of 6 mm. The body reaches its greatest width in the region of the eighth somite where it is 7 mm. wide. At the fourteenth somite the body begins to narrow and the pygidium is 1 mm. wide. There are 78 somites. Anal cirri are lacking in all of the specimens. The prostomium is 3 mm. wide and 3 long. The basal two-thirds is fused on either side with the palps, and beyond this fusion the margins converge so that the apex is about half as wide as the base (Fig. 9). The antennæ are rather stout, about one-half as long as the prostromium, separated at their bases. The palps are heavy, the basal joint extending as far as the end of the antennæ, terminal joints globular, supported on a slender stalk. The prostomium is as long as the two following somites. The tentacular cirri have prominent cirrophores but short styles. The longest one is the anterior dorsal, reaching to the end of the palp; the posterior dorsal is a very little shorter, barely reaching to the posterior border of the prostomium. The anterior ventral is stouter than the corresponding dorsal and about one-half as long. The posterior ventral has similar relations to the posterior dorsal. All cirri and the antennæ have superficial markings resembling articulations toward their ends. The eyes are small, the posterior pair near the posterior prostomial margin, the anterior pair farther apart than the posterior and separated from them by three or four times their diameter. On the anterior margin of the peristomium a median lobe protrudes over the posterior end of the prostomium. The body shows no color markings.

In general, the anterior parapodia have stouter lobes with blunter ends than do the posterior, and the dorsal cirrus is nearer the apex of the lobe posteriorly than



Ceratonereis singularis.

Fig. 1. Head, ×10. Fig. 2. First parapodium, × 28. Fig. 3. Fifth parapodium, × 28. Fig. 4. Epitokal parapodium, × 28. Fig. 5. Posterior parapodium, × 28. Fig. 6. Compound seta, × 250. Fig. 7. Compound seta, × 250. Fig. 8. Epitokal seta, × 250.

Nereis brevicirrata.

Fig. 9. Head, × 12. Fig. 10. Fifth parapodium, × 13. Fig. 11. Posterior parapodium, × 13. Fig. 12. Seta, × 150. Fig. 13. Seta, × 250. Fig. 14. Seta, × 250.

anteriorly. In other respects there are practically no differences in parapodial structure throughout the body. The fifth parapodium (Fig. 10) has two bluntly conical notopodial lobes of which the dorsal is the heavier. A single black acicula and a tuft of setæ come to the surface between these lobes. The dorsal cirrus extends for more than half its length beyond the dorsal lobe and arises near its base. The neuropodium has truncated anterior and posterior setal lobes and a ventral lobe similar in form and size to the dorsal one of the notopodium. It carries a single black acicula. The ventral cirrus arises ventral to the base of the ventral parapodial lobe and is somewhat larger than the dorsal. A posterior parapodium (Fig. 11) has the same general appearance as the anterior but the lobes are more slender and, in the notopodium, more widely separated from one another. The dorsal cirrus arises from farther out on the dorsal lobe and is four times as long as this lobe. The ventral cirrus is longer than the ventral lobe but is more slender than the dorsal cirrus

The notopodial setæ of the anterior somites are few in number, slender, compound, the slender terminal joint toothed along one margin (Fig. 12). In the neuropodium there are, in addition to these slender setæ, other much heavier ones, the terminal joint stout, blunt-ended, with a row of heavy spines along the concave margin (Fig. 13). In the posterior end of the body, the slender setæ of the dorsal tuft become very few or are absent altogether, their place being taken by a few heavy, dark-brown compound ones with the terminal joint lenticular in form and imbedded for about one-half its length in a cavity at the apex of the basal joint (Fig. 14). The neuropodium has the same forms of setæ as in anterior somites but the heavier ones are stouter, their diameter being equal to that of the lenticular setæ. The lenticular setæ resemble those found in *N. procera* Ehlers (1868, 'Die Borstenwürme,' pp. 557–559, Pl. XXIII, fig. 2) and have been regarded as an adaptation to a tube-dwelling mode of life (Johnson, 'Polychæta of the Puget Sound Region,' Proc. Boston Soc. Nat. Hist., XXIX, pp. 400 and 401, Pl. IV, fig. 47, Pl. V, figs. 53 to 59).

The paragnath arrangement is I, one very small one; II, longitudinal rows of about 200 each; III, a patch similar to II, but more numerous paragnaths and arranged transversely; IV, small irregular patch of very few paragnaths; V, absent; VI, four in a rectangle; VII, and VIII, a row of large paragnaths with irregularly arranged smaller ones in front of it.

The type was collected at Key Largo, Florida, by William Beebe and is Cat. No. 1987 in The American Museum of Natural History.

Nereis spinifera, new species

Figures 15 to 20

A single specimen, marked as collected in Puget Sound by E. C. Starks. It is 130 mm. long and has a peristomial width of 5 mm. This width is retained in the anterior somites but the body begins to narrow from the 12th somite backward, the pygidium being only about 1.5 mm. wide. One slender, pointed, anal cirrus remains. The prostomium (Fig. 15) is 2 mm. wide, its length about equal to its width. The eyes are prominent, the anterior being the larger. Just in front of the anterior eye the prostomium narrows abruptly and is definitely coalesced with the inner margin of the palp from here to the anterior angle of the prostomium. The antennæ are conical, about one-quarter longer than wide, and are not in contact at their bases. The palps are heavy, the basal joint extending beyond the ends of the antennæ, the terminal joint having a narrow base and much wider terminal portion. The cirrophores of the tentacular cirri are long as compared with their styles. Of the latter, the posterior dorsal is the longest, reaching to about the middle of the first setigerous somite. The posterior ventral is much shorter, barely longer than the cirrophore of the dorsal. The anterior dorsal has a slender style, shorter than the basal joint of the palp. The anterior ventral has a conical style about twice as long as its cirrophore.

Dorsally the peristomium (Fig. 15) has a lobe protruding over the posterior edge of the prostomium in the mid-dorsal line. On either side of this lobe its length is about equal to that of somite 2, and on the lateral margins it is about one-third longer. The setigerous somites are all of about the same length though varying somewhat in width in different parts of the body.

The first parapodium (Fig. 16) has pre- and postsetal lobes about equal in length, the anterior one entire, the posterior one bifid. There is one very black acicula. Setæ of the dorsal bundle all have long terminal joints. The dorsal-most of the ventral bundle are similar to these but with shorter terminal joints, while the remainder of the ventral bundle have very short but relatively heavy, terminal joints. The dorsal and the ventral cirri are quite similar in form, but the dorsal one is a trifle the longer. Above and below the setal lobe is a heavy rounded lobe, the ventral one of the two being a little more sharply pointed.

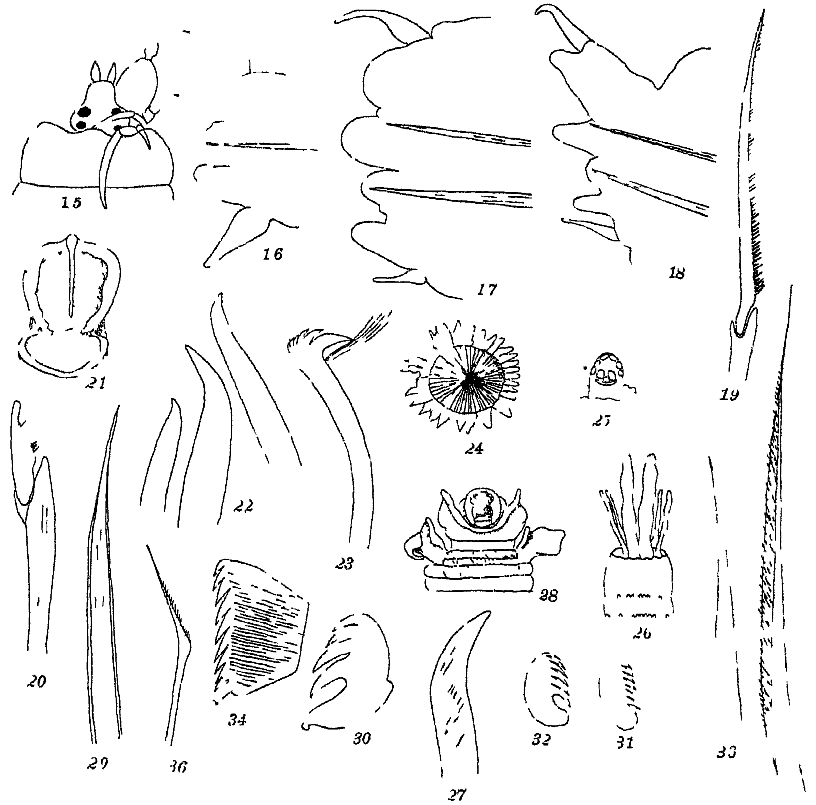
In the 10th parapodium (Fig. 17) the notopodium is composed of two heavy rounded lobes between which the setæ come to the surface. There is no noticeable post- or presetal lip. The dorsal cirrus is short, hardly longer than the setæ. The neuropodium has a thick, conical, ventral lobe and post- and presetal lips. The former is straight, the latter forms a lobe at the end of the acicula, but slopes downward and backward from there. The ventral cirrus is slender and conical, hardly as long as the ventral lobe.

Except that the dorsal cirrus becomes longer and more slender, this type of parapodium is continued to beyond the middle of the body. Toward the posterior end, the dorsal notopodial lobe enlarges, carrying the dorsal cirrus with it (Fig. 18). The figure is drawn from the 90th parapodium, there being about 100 in the entire animal.

The setæ are of two kinds. Those of the dorsal tuft are all alike, with long, pointed, and slightly curved terminal joint. A characteristic feature of these terminal joints is the relatively heavy, spike-like character of the marginal spines (Fig. 19), which are longer than half the width of the joint itself. A few of these setæ occur in the neuropodial tuft, but most of the latter have short, marginally spiny, terminal joints (Fig. 20). The figures are drawn from the setæ of the 1st parapodium. In later ones, there is practically no change in the form of the dorsal setæ and in the ventral ones the apex of the basal joint becomes heavier and dark-colored and the terminal joint is a little shorter.

The arrangement of paragnaths is: I, one large one; II, six or seven small ones in an irregular group; III, about sixteen small ones in an irregularly oval patch; IV, about twenty in an elongate oval figure, those nearest the jaws being much the largest, those farthest away the smallest; V, one large one; VI, one on either side, larger than in V, transversely oval in form, with lateral to each of these a single row of three; VII and VIII, two or three rows running around the pharynx. All paragnaths are dark brown in color. The jaws are dark brown, each having six marginal lobings hardly large enough to be called teeth.

The type is Cat. No. 1988 in The American Museum of Natural History.



Nereis spinifera.

Fig. 15. Head, × 8. Fig. 16. First parapodium, × 18. Fig. 17. Tenth parapodium, × 35. Fig. 18. Ninetieth parapodium, × 18. Fig. 19 Compound seta, × 250. Fig. 20, Compound seta, × 250.

Maldanella corallicola.

Fig. 21. Head, × 5. Fig. 22. Hooks, × 68. Fig. 23, Seta, × 106. Fig. 24. Anal plate, × 5.

Stylarioides dubius.

Fig. 25. Head, × 7.5 Fig. 26. Tentacles, × 7.5. Fig. 27. Hook, × 250.

Loimia minuta.

Fig. 28. Head, × 5. Fig. 29. Seta, × 250. Fig. 30. Uncinus, × 250.

Fig. 31. Uucinus of *Eupomatus similis.*

Hydroides californicus.

Fig. 32. Uncinus, × 250. Fig. 33. Seta, × 106.

Placostegus calciferus.

Fig. 34. Uncinus, × 250. Fig. 35. Seta, × 175. Fig. 36. Abdominal seta, × 250.

Maldanidæ

Maldanella corallicola, new species

Figures 21 to 24

One specimen, collected by the writer in June, 1909, in coral rock near the lighthouse on Loggerhead Key, Dry Tortugas, Florida. The total length is 100 mm. and the greatest width, at the fifth somite, is 4 mm. At the ninth setigerous somite there is a sudden narrowing to 2 mm. in body width and this continues throughout the remainder of the body. There are 19 setigerous somites. In the first two the length is about equal to the width, in the third the length is about one-quarter less than the breadth and this proportion is maintained as far as, and including the eighth somite. Beginning with the ninth setigerous somite, they elongate relatively so that their length is three or four times their breadth. Because of distortion in the preservation, however, significant measurements are hard to get.

The cephalic plate (Fig. 21) makes an angle of about 30° with the first setigerous somite. The center of its anterior margin is marked by a conical protrusion which is the anterior end of a longitudinal ridge which is continued more than half-way across the dorsal surface of the plate. The entire margin of the cephalic plate, except for a considerable notch on either side, is expanded into a prominent fold.

The first setigerous somite has a dorsal tuft of slender, sharp-pointed setæ and a ventral one of three heavy hooks. The setæ are straight or very slightly bent and vary considerably in size. They are bilimbate, though this feature is much less easily seen in the smaller ones. The hooks (Fig. 22) have darker bases with much lighter apices. Their relative sizes are shown in the figure. At the fourth setigerous somite the places of the hooks are taken by a torus carrying a single row of stout setæ. Each seta (Fig. 23) has a heavy stem, terminating in an expanded head. The latter carries a strong ventral tooth with a diminishing row of smaller ones dorsal to it. A tuft of long, slender threads rises from the lower side of the large ventral tooth. In all subsequent somites both forms of setæ occur. Toward the posterior regions the notopodial lobe protrudes farther from the surface than in the anterior, and the torus is elevated above the general surface level. The first torus is short, but later ones are much elongated, leaving in each somite a space between the ventral ends not more than one-sixth the length of either torus. The tori make up the equivalent of stiff belts around the middle of the somites and their protrusion may be in part due to the shrinkage of the softer portions of the body wall as a result of the preservation.

The anal funnel (Fig. 24) has 29 marginal lobes, but a gap a little to the left of the midline on the ventral margin may indicate the loss of a lobe or lobes at this place. The lobes are very unequal in size and there is no regularity in their arrangement. The smallest are on the dorsal margin and are blunt-pointed, while much larger sharp-pointed ones lie opposite them on the ventral margin. Two lobes are larger than any of the others, and some are bifid.

The type is Cat. No. 1989 in The American Museum of Natural History.

Flabelligeridæ

Stylarioides dubius, new species

Figures 25 to 27

The body length averages about 15 mm. with a width in the widest portion of less than 2 mm. From the head region there is a very gradual increase in width up to the fifth somite. This width is maintained for the next 10 somites when there follows a progressive narrowing for 5 or 6, while the last 25 of the body somites are not more than half the width of the widest anterior portion There is a very thin incrustation over the entire body and on the dorsal surface of the first 5 somites this is thickened by a deposit of fine white sand grains. Small papillæ occur all over the body. In the first 4 setigerous somites they are definitely arranged in a band around the middle of the somite, in later ones they still have in general a circular arrangement but this is more irregular and in the posterior part of the body they are quite irregularly distributed and are comparatively scarce.

The first 3 setigerous somites are obliquely truncated dorsally, the truncated surface being flat and covered with white sand. In only one specimen is there any indication of a head (Fig. 25). Here there is a narrow "neck," evidently the peristomium, with the horseshoe-shaped prostomium on its anterior end. The latter shows the scars of attachment of 6 distinct appendages, and 3 lobes surround the mouth. In another specimen there were two larger lobes which I consider to be the palps and on either side two smaller ones which are the tentacles (Fig. 26). In all of the other specimens the head is entirely retracted into the first setigerous somite. From the ventro-lateral surface of the first setigerous somite a tuft of very long setæ extends for a considerable distance in front of the head.

These setæ evidently correspond to the neuropodial. I was unable to find any trace of notopodial ones in any part of the body. A ring of the entire body, cut from the abdominal region and covering several somites was split and the internal organs removed so that there remained only the body wall. This was spread out flat on a slide and examined under a lens. No trace of notopodial setæ could be found, though the two bundles of neuropodial spines were very easily seen. These spines (Fig. 27), are very stout, curved, and only moderately pointed. This lack of neuropodial setæ may possibly indicate a new genus.

Collected by the writer at the Dry Tortugas, Florida, in 1910.

The paratypes are Cat. No. 1990 in The American Museum of Natural History.

In 1928, in a collection of polychætes from Haiti, I described (Treadwell, 'Polychætous Annelids from the "Arcturus" Oceanographic Expedition,' Zoologica, New York Zoölogical Society, VIII, No. 8, Dec.) a new species, *Semiodera glabra,* and with it a tentatively new species, *stylarioides.* The latter is identical with *S. dubius.*

The collections of The American Museum of Natural History contain specimens from British Somaliland. While most of these belong to easily recognized old species, two are obviously new. Each is represented by only one incomplete specimen so that I am unwilling to attempt species diagnoses, but it seems wise to record them on the chance that they may appear in other collections, in which case the record of their occurrence in Somaliland will be of interest. One of these is the *Audouinea* to be immediately described and the other is *Eupomatus operculata* whose description will be found under the family Serpulidæ.

Cirratulidæ

Audouinea maculata, new species

A single specimen, about 20 mm. long and 4 mm. wide. The body is densely spotted with dark brown or black so that its naked-eye appearance is almost black. The lateral cirri apparently extend throughout the body, but they are now in such a tangled mass that their precise arrangements are very difficult to determine. Dorsal cirri occur in a transverse row on the sixth setigerous somite. These are much smaller than the lateral ones and are either colorless or marked with narrow dark bands on the white surface.

Somite I, in dorsal view, is about as wide as long, narrowing a very little toward the anterior end. The mouth is ventral and is overhung by the margin of the prostomium, the boundary between the pro- and peristomium having been obliterated. The second somite is a little wider than the first and subsequent ones widen rather rapidly up to the region of the twelfth setigerous somite where the body reaches its full width. Setæ begin on the third somite.

Setæ occur in dorsal and ventral bundles and, except that the dorsal setæ are the longer, there is practically no difference between them. They are all narrow, curved, and very sharp-pointed, but, especially in the ventral bundle, differ somewhat in length.

Collected at Berbera, British Somaliland, Feb. 21, 1921, by Barnum Brown.

The type is Cat. No. 1991 in The American Museum of Natural History.

Terebellidæ

Loimia minuta, new species

Figures 28 to 30

A single small specimen, collected by the author at the Dry Tortugas, Florida, in 1910. The thoracic region is 11 mm. long and 2.5 mm. wide at the eighth somite. From this latter point there is a very slight narrowing toward the head but hardly any narrowing to the posterior end of the thorax. The anterior abdominal somites narrow regularly so that the sixth is about one-half as wide as the first. Behind the sixth the abdominal width is constant to the end of the body which is incomplete. The portion of the abdomen remaining is 11 mm. long.

The upper lip (Fig. 28) is horseshoe-shaped, with the margins more or less recurved. The tentacles occupy the usual position on the dorsal surface. Most of them have been lost but those remaining are relatively long and stout, and marked with narrow transverse brown bands, set close together. The lower lip is inconspicuous, being largely hidden by the anterior margin of a transverse fold which runs across the ventral face of the second somite and widens at either end to form a broad plate which extends dorsally so far as to conceal the first somite when viewed from the side.

A smaller lateral fold appears on either side the third somite but does not extend across the ventral surface.

The first ventral plate (Fig. 28) is common to the second and third somites, though these somites are distinct dorsally and laterally. A very delicate transverse furrow marks the boundary of these two somites on the plate and a similar line runs across the middle of the part of the plate belonging to the second somite. Irregular lines cut up the latter into small areas while in the part of the plate belonging to somite 3 these lines all run longitudinally. The following ventral shields are marked by longitudinal lines only. The plates are entire as far as the tenth but the eleventh, twelfth and thirteenth are bisected by a transverse line, while the fourteenth and last is trisected by two transverse lines.

There are three pairs of dichotomously branched gills on somites 2, 3 and 4. The first pair has the largest stalk and the third is smaller than the second, but the size differences between them are not very noticeable.

Setæ begin on the fourth somite, and tori with uncini on the fifth. There are seventeen setigerous somites. The setæ are quite similar in form, differing only in size. They (Fig. 29) are very sharp-pointed and slightly curved. In the larger ones the bilimbate character is very clearly seen, but in the smaller this is more obscure. The uncini have four prominent teeth (Fig. 30).

The type is Cat. No. 1992 in The American Museum of Natural History.

Serpulidæ

In a bottle labeled "from Lower California," collected by C. H. Townsend in 1911, but giving no other locality data, was a mass of limestone tubes containing serpulids. Unfortunately, no record was made of the character of the tubes which were necessarily destroyed in removing the animals and it was not until later that I discovered that two genera are represented.

Eupomatus similis, new species

Figure 31

The total length is 12 mm. of which the branchiæ make up 2 mm. There are 12 or 13 branchiæ on either side, each having a long and slender apical portion free from branchiales. In two of the three specimens the opercular stalk is on the right side, in the other it is on the left. The stalk extends to the end of the branchiæ as a cylindrical structure nearly twice as great in diameter as a branchia. At the apex it expands into a shallow cup with approximately 40 blunt marginal teeth. On its distal face a cup-shaped structure rises from its center. This has a heavy base and its margin carries approximately 20 stout hooks inwardly curved at the ends. As is characteristic of the genus *Eupomatus*, these hooks have no lateral branches. The only trace of color shown on the entire animal is on the base of the distal opercular cup which is dark brown, and similar color occurs on the marginal teeth of the proximal cup. The collar is thin, extending anteriorly nearly one-quarter of the length of the branchiæ.

On either side of the dorsal surface, the dorsal end of each row lying close to the opercular stalk of its side, is a diagonal row of stout setæ, recognizable from their golden color against the white body. These setæ are of two kinds: the larger having heavy stalks and trifid ends, two of these terminal divisions being short, and blunt; the other long and sharp-pointed. Together with these is a smaller number of long, slender setæ. In the following six setigerous somites there are dorsal bundles of long, slender, curved awl-shaped setæ and ventral tori. The uncini each have 7 teeth (Fig. 31).

Collected in Lower California in 1911, by C. H. Townsend.

The type is Cat. No. 1993 in The American Museum of Natural History.

Eupomatus operculata, new species

A single specimen, incomplete posteriorly, the fragment being 10 mm. long and more than 0.5 mm. wide. The collar is well developed, its margin extending rather more than halfway from the base of the gill to where the latter divides into separate filaments. Seven much coiled filaments make up the gill of one side but they are broken away from the other. On the right side is an operculum with a stalk twice as long as the gill. On the left side is another operculum exactly like this in form, but with a much shorter stalk. The operculum proper has the usual form of an inverted cone or funnel, with its margin cut into about 40 sharp-pointed, colorless spines. From the center of the truncated end arises a central dark-colored, rather heavy stalk, prolonged into 7 long, curved processes.

Collected at Berbera, British Somaliland, Feb. 21, 1921, by Barnum Brown.

The type is Cat. No. 1994 in The American Museum of Natural History.

Hydroides californicus, new species

Figures 32 and 33

In size, body color and general appearance this shows no differences from the above described *Eupomatus*, the only distinction being in the structure of the operculum. In this the stalk is like that of *E. similis* but the marginal teeth of the terminal expansion are about 30 in number and long and sharp-pointed. There are 9 opercular spines which are longer and more decidedly curved than in *E. similis*, and each has a small spine on either side, attached about midway of its length and extending at right angles to the main axis. The presence of these spines places this specimen in the genus *Hydroides*. The setæ (Fig. 33) are exactly similar to those of *E. similis*, and the uncini are essentially similar but have 6 instead of 7 teeth (Fig. 32).

Collected by C. H. Townsend in 1911, in Lower California.

The type is Cat. No. 1995 in The American Museum of Natural History.

Placostegus calciferus new species

Figures 34 to 36

A single specimen which at first was difficult to locate in its proper species because of the apparent lack of collar setæ. However, these are present, though deeply imbedded in the collar tissue and difficult to find. The animal is 20 mm. long, the gills making up 3 mm. of this length. On either side are about 23 branchiæ of unequal lengths, the longest being on the dorsal surface, those of the ventral end being much shorter and inrolled for more than a complete circle. They are rather heavy and are united for more than half their length by a basal membrane. In this preserved specimen the bases of the branchial lobes, as far as the outer margin of the basal membrane, are brown in color. The free portions of the branchiæ are alternately banded with colorless and brown. The operculum arises in the mid-dorsal line and in the contracted condition of the preserved specimen extends considerably beyond the ends of the branchiæ. From base to apex, its stalk is strongly calcified and marked with longitudinal ridges. At the outer end, the stalk expands rather asymmetrically into the 2 mm. wide opercular plate. On the margin this plate carries (seen to best advantage when viewed from below) a marginal row of bluntly rounded, brown-colored teeth. Some have been broken away, but, if evenly spaced all the way around the margin, the total number should be about 16. Distally the plate carries a thick deposit of limestone which is hollowed to form a shallow cup and from the margin of this cup series of irregular lamellar ridges extend to converge at the center, the whole resembling a water-worn coral cup with its septa.

The thoracic membrane is very prominent, its dorsal margin extending as far as the ends of the branchiæ. About halfway to the ventral surface on either side it becomes abruptly shorter and is continued with this length to the ventral surface. It is too badly preserved to allow of accurate description or drawing. It covers only the first setigerous somite of the thorax, leaving the other six entirely uncovered. In each of these the raised posterior margin, carrying the uncini, extends as a fold over the anterior margin of the somite behind it. The abdomen tapers gradually to a blunt end. Ventrally it shows a wide shallow depression which is most in evidence at the posterior end.

The thoracic uncini are trapezoidal in outline and each has 9 sharp teeth, the largest in the middle of the series (Fig. 34). Basal to the last tooth is a cylindrical process a little longer than the tooth and distinctly hollowed at the end. There are two kinds of thoracic setæ, the larger having shafts about twice as thick as the smaller. Toward the apex each larger one bends and from the point of bending tapers to an acute tip. This tapered portion may be straight or it may bend in either direction. Along the convex surface is a marginal wing which is covered by fine striations (Fig. 35). A very narrow wing lies along one margin of the finer seta, but the bending is never as marked in these as it is in the larger ones. The abdominal setæ (Fig. 36) have extremely long and slender stalks and are geniculate at the ends with a row of fine teeth along the apical margin. The abdominal uncini are similar to those of the thorax.

The specimen was collected in Julia Cove, Guanica Harbor, Porto Rico, by R. W. Miner, June 23, 1915 "from calcareous tube grown firmly on a shell." The specific name refers to the calcified character of the operculum.

The type is Cat. No. 1996 in The American Museum of Natural History.

AMERICAN MUSEUM NOVITATES

Number 393
Published by
The American Museum of Natural History
New York City
Dec. 24, 1929

56.9,61

NEW EURASIATIC AND AMERICAN PROBOSCIDEANS[1]

By Henry Fairfield Osborn

The reader is referred to previous systematic revisions by the present author, also to his forthcoming Memoir, now on the American Museum press:

EVOLUTION OF THE PROBOSCIDEA

All the figures in this number of Novitates are reproduced from original type figures by Lindsey Morris Sterling in the above-mentioned Memoir. Certain of the advance page proofs of this Memoir have been sent to Mr. Arthur T. Hopwood of the British Museum and to Dr. Ángel Cabrera of the Museo de La Plata, Argentina. A full set of page proofs to the end of Chapter XX (the Elephantinæ) is accessible in the Osborn Research Room of the American Museum.

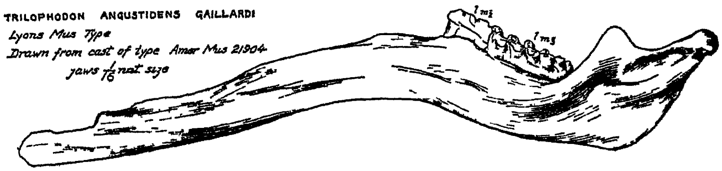

TRILOPHODON ANGUSTIDENS GAILLARDI
Lyons Mus Type
Drawn from cast of type Amer Mus 21904
jaws 1/16 nat size
r m2
r m3

Fig. 1. Type lower jaw, with M_2, M_3 *in situ*, of *Trilophodon angustidens gaillardi* (cast Amer. Mus. 21904). One-sixteenth natural size.

Subfamily: **LONGIROSTRINÆ**

TRILOPHODON ANGUSTIDENS GAILLARDI, new subspecies

TYPE.—Original in the Muséum des Sciences Naturelles de Lyon, France; cast Amer. Mus. 21904, presented to the American Museum by Dr. Claude Gaillard. A lower jaw with M_2, M_3 *in situ*.

LOCALITY.—Villefranche-d'Astarac (Gers), France.

HORIZON.—Probably of Pliocene age.

SPECIFIC CHARACTERS.—Distinguished from the typical *Mastodon* [=*Trilophodon*] *angustidens* of Simorre and Sansan by the length of the jaw (total 1495 mm.), the expansion of the ramus at the symphysis, the presence of 5½ ridge-crests in the third inferior molars (length of r.M_3 190 mm.). The distal expansion of the symphysis may relate this form to the 'shovel tuskers' *Amebelodon* Barbour and *Platybelodon* Borissiak.

See Chapter VIII of the Proboscidea Memoir.

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[1] This is the author's nineteenth communication on the evolution and classification of the Proboscidea since 1918, and the twenty-ninth in his total list of papers on the Proboscidea since 1907. See the author's forthcoming chronologic and classified Bibliography to the end of the year 1929.

Subfamily: **SERRIDENTINÆ**

SERRIDENTINUS BIFOLIATUS, new species

TYPE.—Amer. Mus. 1875. A third lower molar of the left side, l.M_3, presented to the American Museum by Professor Raymond of Columbia University.

PARATYPE.—Geol. Surv. Florida 7700. A left mandibular rámus with M_3 *in situ.*

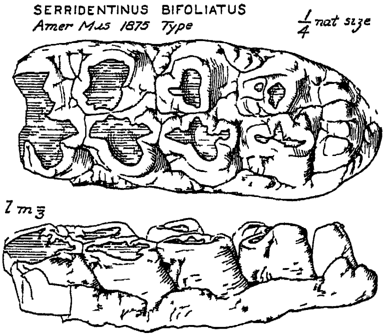


Fig. 2. Type l.M_3 of *Serridentinus bifoliatus* (Amer. Mus. 1875). One-fourth natural size.

LOCALITY.—Brewster, Polk County, Florida.

HORIZON.—Upper Pliocene (?), Alachua clays.

SPECIFIC CHARACTERS.—The specific name *bifoliatus* refers to the double trefoils shown on the three anterior ridge-crests of the type, also to the presence of five ridge-crests in the third left inferior molar, l.M_3, which measures, ap. 195 mm., tr. 81 mm., index 42. This is the most progressive stage thus far discovered.

See Chapter X of the Proboscidea Memoir.

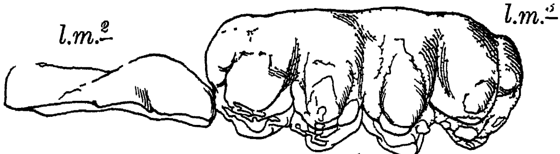
SERRIDENTINUS HASNOTENSIS, new species

COTYPES.—Amer. Mus. 19948, an incomplete third right superior molar, r.M^3, with 3+ ridge-crests (4⅓); Amer. Mus. 19738, a third right superior molar, r.M^3, with 4⅓ ridge-crests; Amer. Mus. 19838, second and third superior molars of the left side, l.M^2 (?), l.M^3, with 4 and 4⅓ ridge-crests respectively.

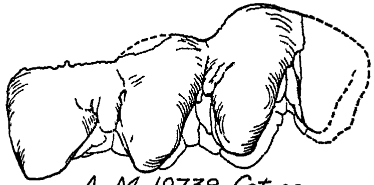
LOCALITY AND HORIZON.—Amer. Mus 19948, two miles northeast of Hasnot, upper Middle Siwaliks; Amer. Mus. 19738, one mile northeast of Hasnot, Middle Siwaliks, above middle beds; Amer. Mus. 19838, four miles west of Dhok Pathan, *Hipparion* quarry level, 500 feet below top of Middle Siwaliks. Collected by Barnum Brown in the Dhok Pathan horizon, India, in 1922.

SPECIFIC CHARACTERS.—Ridge formula: M 2 $\frac{\frac{1}{2}\text{-}3\text{-}\frac{1}{3}}{\quad}$ M 3 $\frac{4+\text{talon}}{\quad}$ Ridge-crests massive, separate, vertical; strong internal, rudimentary external trefoils; cement in valleys. Measurements: r.M^3, height of metaloph 75 mm., three anterior crests, proto-, meta-, and tritolophs = 146 mm.; r.M^3, ap. 190e mm., tr. 94 mm., height of metaloph 69 mm , ap. of proto-, meta-, tritolophs = 143 mm.; l.M^2 (?), ap. 108 mm., tr. 74 mm.; l.M^3, ap. 160 mm., tr. 92 mm. Agree closely in subhypsodonty with ridge-crests of *Serridentinus dhokpathanensis.*

See Chapter X of the Proboscidea Memoir.

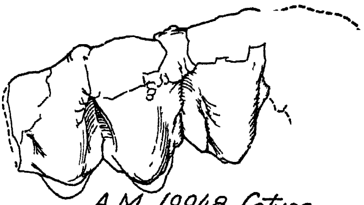


S. HASNOTENSIS *A. M. 19838 Cotype*



S. HASNOTENSIS *A. M. 19738 Cotype*

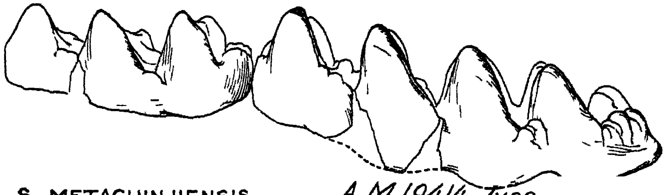
r. m$\frac{3}{}$ (rev.)



S. HASNOTENSIS *A.M. 19948 Cotype*

r. m$\frac{3}{}$ *inner view*

Fig. 3. Cotypes of *Serridentinus hasnotensis* (Amer. Mus. 19948, 19738, 19838) One-fourth natural size.



S. METACHINJIENSIS *A.M 19414 Type*

r. $m_{\overline{2}}$-$_{\overline{3}}$ *inner view*

Fig. 4. Type r.M$_2$, r.M$_3$ of *Serridentinus metachinjiensis* (Amer. Mus. 19414). One-fourth natural size.

SERRIDENTINUS METACHINJIENSIS, new species

TYPE.—Amer Mus 19414. Portion of right inferior ramus with M_2, M_3 complete, beautifully preserved

LOCALITY.—One mile northwest of Chinji Bungalow, India.

HORIZON.—Collected in 1922 by Barnum Brown in the Lower Chinji horizon, 800 feet above base of Lower Siwaliks, Middle Miocene

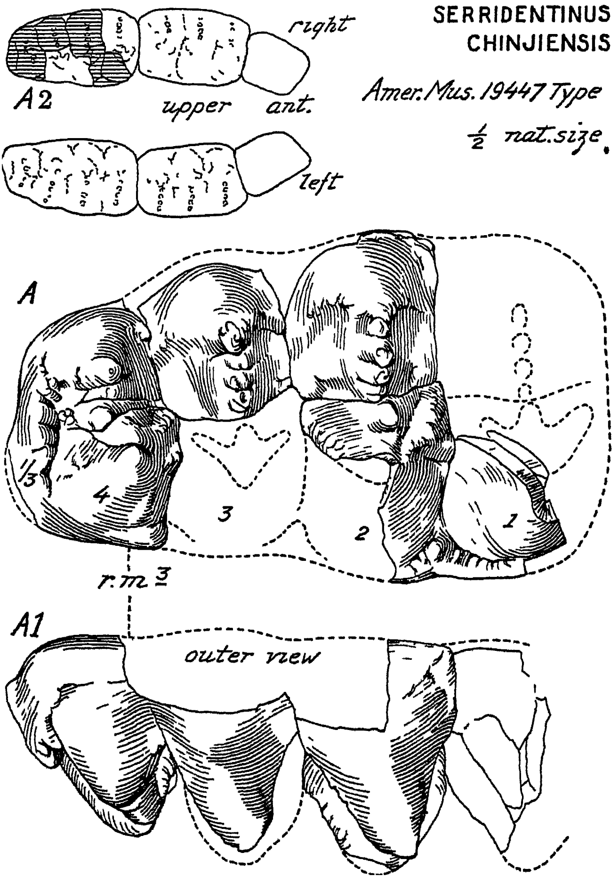


Fig. 5. Type r.M^3 of *Serridentinus chinjiensis* (Amer. Mus. 19447). One-half natural size.

SPECIFIC CHARACTERS.—Right third inferior molar, r.M_3, with 4½ ridge-crests, subhypsodont, no cement, anteroposterior measurement 214 mm., transverse 85 mm., height of metalophid 75 mm.; r.M_2, anteroposterior measurement 131 mm, transverse (protolophid) 51 mm, (tritolophid) 64 mm., i.e., widening posteriorly, height of metalophid 53 mm. Single external trefoils, low postcingulum with many conelets and single prominent cone (tetartolophid); *S. serridens* exhibits two prominent cones, also *S. prochinjiensis*, new species, has two cones, in fact, the double cones in M_2 are very characteristic. Summits of lophs with four to five conelets. Compare *S. serridens* of the Clarendon beds, Lower Pliocene of Texas, and *S. productus* of the Santa Fé marls, Upper Miocene of New Mexico.

See Chapter X of the Proboscidea Memoir.

Serridentinus chinjiensis, new species

Type.—Amer. Mus. 19447. An imperfect right third superior molar, r.M^3, with 4 ridge-crests plus cingulum. Measurements: ap. 160e mm., tr. 91 mm., height of metaloph 52e mm.

Locality.—One mile and a half west of Chinji Bungalow, India.

Horizon.—Collected in 1922 by Barnum Brown 700 feet above base of Lower Siwaliks, Lower Chinji horizon. Middle Miocene.

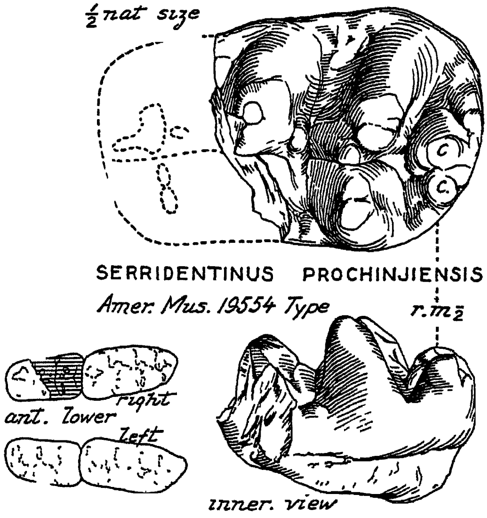


Fig. 6. Type r.M_2 of *Serridentinus prochinjiensis* (Amer. Mus. 19554). One-half natural size.

Specific Characters.—This stage is clearly distinguished from, and is much more primitive than *Serridentinus metachinjiensis*, new species, i.e., more brachyodont, with smooth-sided crowns, 7–6 conelets on metaloph and tritoloph, trefoils sharply defined in median aspect, both external and internal cones sloping inwards, contour of crowns subtriangular, broad anteriorly, narrowing posteriorly, tetartoloph with five conelets, internal cones less prominent than external.

See Chapter X of the Proboscidea Memoir.

SERRIDENTINUS PROCHINJIENSIS, new species

TYPE.—Amer. Mus. 19554. A right second inferior molar, r.M_2, with metalophid and tritolophid and a pair of posterior cones only. Measurements: ap. 105e mm., tr. 58 mm., height of tritolophid 41e mm.

LOCALITY.—Two miles west of Chinji Bungalow, India.

HORIZON.—Collected in 1922 by Barnum Brown 600 feet above base of Lower Siwaliks, Lower Chinji horizon. Miocene.

SPECIFIC CHARACTERS.—Small, very primitive; rudiment of external trefoil conule in valley between meta- and tritolophids; two small characteristic cones rising on posterior cingulum, as in *Serridentinus serridens;* lophs low and simple, barely subdividing into conelets; breadth of tritolophid 65 mm. as compared with 79 mm. in *S. serridens;* height of tritolophid 41e mm. as compared with 61 mm. in *S. serridens.*

See Chapter X of the Proboscidea Memoir.

This single fractured type specimen reveals the presence in India of an ancestral phase of *Serridentinus* much more primitive than *S. mongoliensis* of the Lower to Middle Miocene of Mongolia.

SERRIDENTINUS FLORESCENS, new species

TYPE.—Amer. Mus. 21615. Second inferior molar of the right side, r.M_2, crushed laterally. Length of type crown 131e mm., breadth of tritolophid 45+ mm.

LOCALITY.—Kholobolchi Nor region, Mongolia, five to eight miles north of camp. Collected by Walter Granger on June 30, 1925.

HORIZON.—Khunuk formation, Pliocene, possibly equivalent to the Hung Kureh beds of the Tsagan Nor region.

SPECIFIC CHARACTERS.—The specific name *florescens* refers to the remarkable florescence or blossoming out of the external trefoil spurs into broad anteroposterior plates crowned with four to five conelets which greatly exceed in prominence those of any other species of *Serridentinus.* The length of the type crown (131e mm.) exceeds that of r.M_2 in *S. mongoliensis* (108 mm.); the breadth of the tritolophid is 45+ mm. and is greatly contracted by lateral crushing. *S. florescens* appears to represent a progressive stage in the blunt-coned series of *Serridentinus,* beyond *S. mongoliensis* of the Lower to Middle Miocene of Loh, out of which stage it has evolved.

See Chapter X of the Proboscidea Memoir.

Subfamily: **RHYNCHOROSTRINÆ**

RHYNCHOTHERIUM PAREDENSIS, new species

TYPE.—Amer. Mus. 18216B, 18218. Immature mandible containing l. Dp_2, r. and l. Dp_3, Dp_4, and both tusks (Amer. Mus. 18216B); a left maxilla (Amer. Mus. 18218) containing l.Dp^2, Dp^3, Dp^4 (Frick, "Tooth Sequence in Certain Trilophodont Tetrabelodont Mastodons," Bull. Amer. Mus. Nat. Hist., Vol. LVI, Art. II, 1926, p. 170)—probably belonging to one individual.

LOCALITY.—Mt. Eden Hot Springs, San Bernardino County, California.

HORIZON.—Collected by Joseph Rak in the Eden formation, Upper Pliocene, during the winter of 1916–1917. Part of the Frick Collection.

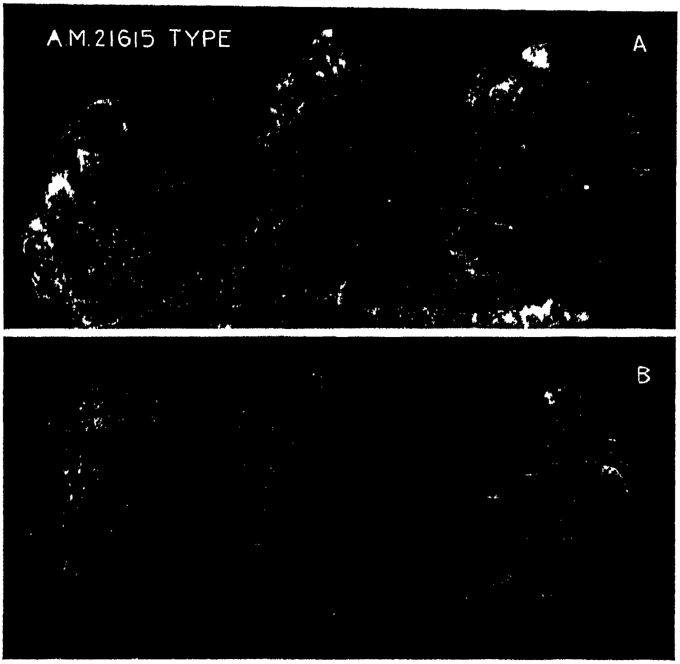


Fig 7 Type 1 M_2 of *Serridentinus florescens* (Amer Mus 21615) About two-thirds natural size

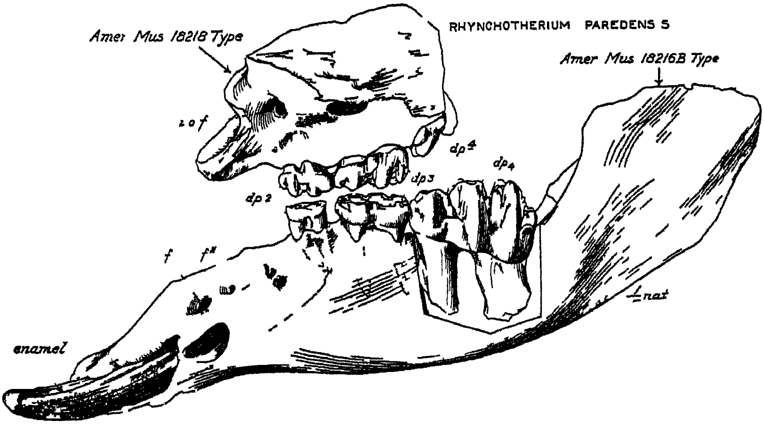


Fig 8 Type mandible (Amer Mus 18216B) and maxilla (Amer Mus 18218) of *Rhynchotherium paredensis* One-fifth natural size

Specific Charactfrs.—The right lower tusk, r.I_2, is closely compressed vertically; the lower deciduous premolars, Dp_3, Dp_4, are trilophodont or three crested, with rudimentary conelets partly blocking the valleys on the external side, while in the corresponding superior tooth, namely, l.Dp^4, the rudimentary conelets block the valleys on the internal side, as in *Serridentinus;* the crowns are covered with irregular tubercles or are 'chœrodont' in type, as in all deciduous premolars of the trilophodonts.

See Chapter XI of the Proboscidea Memoir.

Rhynchotherium chinjiensis, new species

Type.—Amer. Mus. 19415. Left ramus with warped alveolus of left inferior incisor, l.I_2; also l.M_2, M_3 *in situ.*

Locality.—Two miles west of Chinji Bungalow, India.

Horizon.—Collected in 1922 by Barnum Brown 600 feet above the base of the Lower Siwaliks.

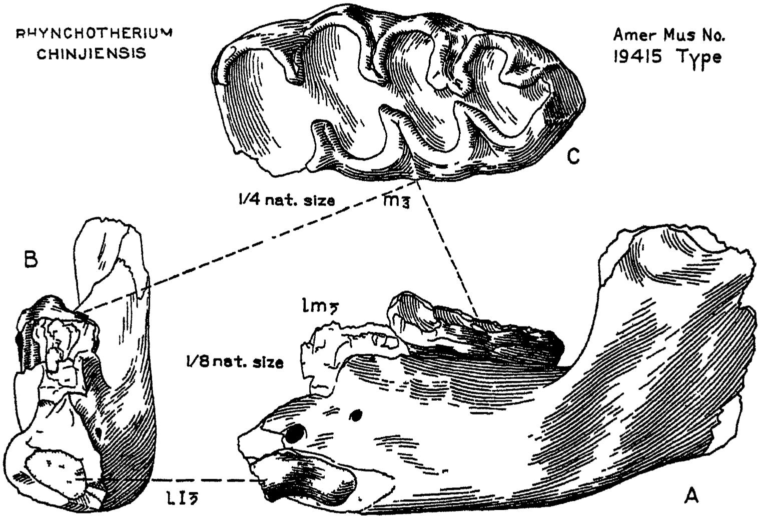


Fig. 9. Type ramus with l.M_2, l.M_3 *in situ,* also warped alveolus of l.I_2, of *Rhynchotherium chinjiensis* (Amer. Mus. 19415). One-eighth natural size. Crown view of l.M_3 one-fourth natural size.

Specific Characters.—Mandibular ramus deep, abbreviate, rostrum apparently downturned, containing alveolus of a single flattened incisor, warped in the type. Third inferior molar brachyodont, four crested, with thick enamel, ap. 200 mm., tr. 92 mm., thus resembling *Rhynchotherium euhypodon.*

See Chapter XI of the Proboscidea Memoir.

The generic reference of this type is somewhat uncertain owing to the imperfect condition of the rostrum.

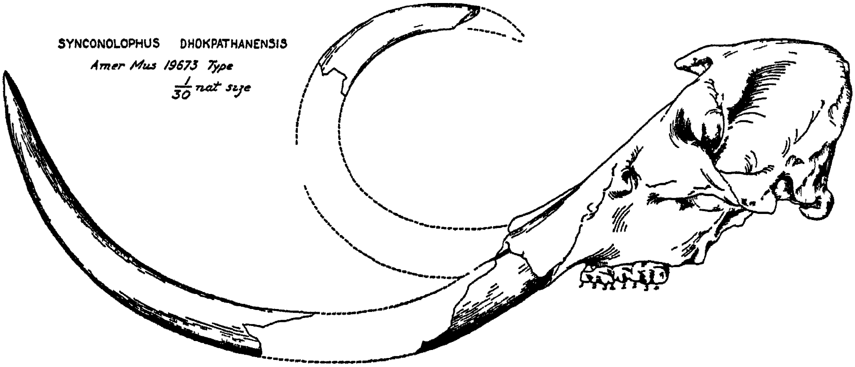
Subfamily: **BREVIROSTRINÆ**

SYNCONOLOPHUS, new genus

GENOTYPIC SPECIES.—*Synconolophus dhokpathanensis*, new species.

GENERIC CHARACTERS.—Skull somewhat more elongate than in *Anancus*, *Pentalophodon*, or *Stegomastodon*. Basicranium elongate, also palate. Postnarial opening far back of grinders (*Synconolophus dhokpathanensis*). Tusks large, upturned, without enamel. Intermediate molars, Dp 4–M 2, with trilophodont ridge formulæ and small rudimentary half ridge-crests, representing pro-protoloph and tetartoloph. Grinders with ridge-crests strongly arched or dislocated. Valleys blocked with single, double, or multiple trefoil conelets, giving on wear a strongly chœrodont, ptychoid, crowded, compressed, enamel-bordered appearance, as implied in the generic name *Synconolophus*. Mandible (*S. propathanensis*) with elongate, downturned rostrum; tusks small or absent. Ridge formula: Dp 4 $\frac{\frac{1}{2}\text{-}3}{\quad}$ M 1 $\frac{\frac{1}{2}\text{-}3\text{-}\frac{1}{2}}{\quad}$ M 2 $\frac{\frac{1}{2}\text{-}3\text{-}\frac{1}{2}}{\quad}$ M 3 $\frac{\frac{1}{2}\text{-}4\text{-}\frac{1}{2}}{\frac{1}{2}\text{-}5\text{-}\frac{1}{2}}$.

See Chapter XIII of the Proboscidea Memoir.



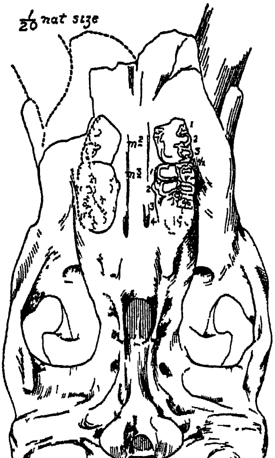


Fig. 10. Type cranium of *Synconolophus dhokpathanensis* (Amer. Mus. 19673). Left lateral view, one-thirtieth natural size; palatal view, one-twentieth natural size.

This genus is superbly represented by the type cranium and superior dentition of *Synconolophus dhokpathanensis*, new species, supplemented by the unworn superior molar of the paratype; by the type and four other specimens referred to *Synconolophus ptychodus*, new species, of the Lower Chinji horizon, and one from 1,000 feet below the Bhandar Bone-bed; by numerous examples of grinding teeth erroneously referred by Lydekker to the following species (*Mastodon pandionis, M. sivalensis*), as well as by the types of *Tetrabelodon corrugatus* and *Mastodon hasnoti* of Pilgrim, and finally by the tuskless lower jaw, with both pairs of inferior grinders, M_2, M_3, of *Synconolophus propathanensis*, new species. These reveal a new generic phylum extending from the Lower Chinji into the Dhok Pathan horizon, as one of the most important additions which Barnum Brown has made to the history of palæontology. As in *Anancus* and in *Stegomastodon*, the transverse crests are strongly oblique, but *Synconolophus* is readily distinguished by the multiplication of the cones and conules which finally render the molar a bewildering complex, of a warped, chœrodont, ptychoid pattern.

SYNCONOLOPHUS DHOKPATHANENSIS, new species

TYPE.—Amer. Mus. 19673. Cranium with portions of right and left superior tusks, and M^2, M^3 of both sides *in situ*.

LOCALITY.—Three miles west of Dhok Pathan, India.

HORIZON.—Discovered by Barnum Brown (1922) 500 feet below the top of the Middle Siwaliks, Lower Pliocene.

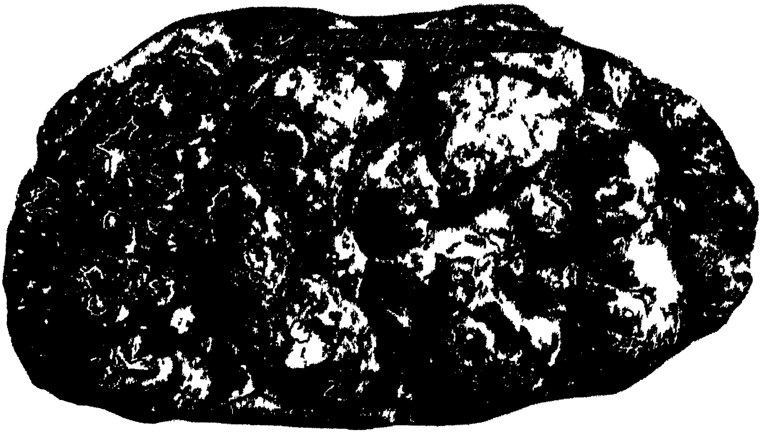


Fig. 11. Paratype r.M^3 of *Synconolophus dhokpathanensis* (Amer. Mus. 19720), one-half natural size.

PARATYPE.—Amer. Mus. 19720. Unworn third right superior molar, r.M^3, from Dhok Pathan, India, approximately 500 feet below the top of the Middle Siwaliks, same level as *Hipparion* quarry. Length 200 mm., breadth 106 mm., index 53.

SPECIFIC CHARACTERS.—*Synconolophus dhokpathanensis* is the most progressive species of the Dhok Pathan horizon, succeeding the two somewhat simpler stages *S. corrugatus* Pilgrim and *S. hasnoti* Pilgrim. In case further material should demonstrate specific resemblance, *S. dhokpathanensis* might become a synonym of *S. corru-*

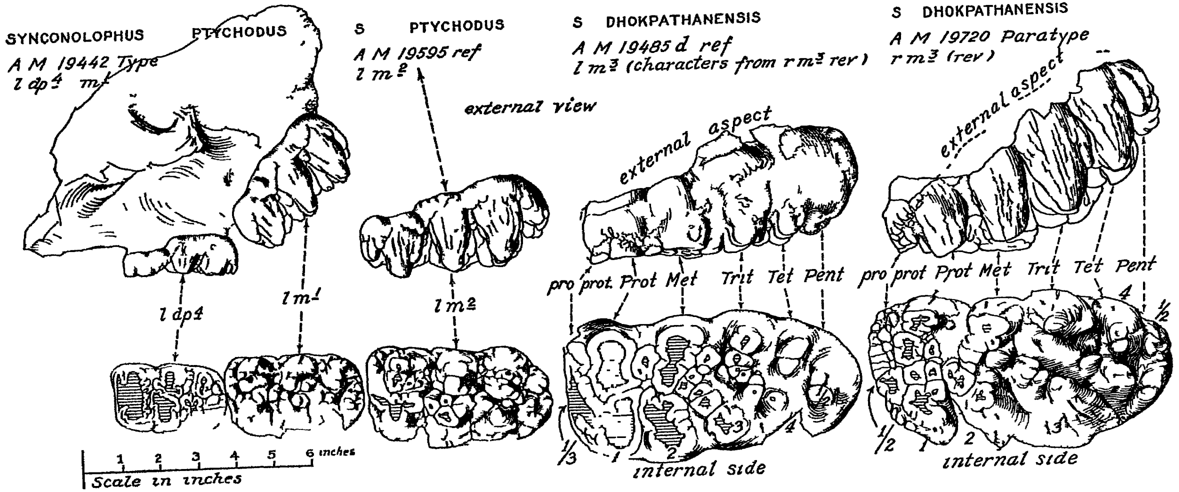


Fig 12 Type of *Synconolophus ptychodus* (Amer Mus 19442) and referred specimen (Amer Mus 19595) also referred specimen of *S dhokpathanensis* (Amer Mus 19485-d) and paratype (Amer Mus 19720) One-fifth natural size

gatus. Unfortunately the aged grinding teeth of the type are badly damaged, so that it is difficult to determine the ridge formula with precision; it is apparently as follows: r.M 2 $\frac{3\frac{1}{2}}{}$ r.M 3 $\frac{\frac{1}{2}-4-\frac{1}{2}}{}$.

Characters of Paratype.—Cones deeply grooved; enamel ptychoid; single intermediate conelet on metaloph; cement strongly developed; total superior conelets 41–44. Ridge formula: M 3 $\frac{5\frac{1}{2}}{}$.

See Chapter XIII of the Proboscidea Memoir.

Synconolophus ptychodus, new species

Type.—Amer. Mus. 19442. Fragment of left maxilla with l.Dp^4, l.M^1.

Locality.—Four miles west of Chinji Bungalow, India.

Horizon.—Collected by Barnum Brown 800 feet above base of Lower Siwaliks, Lower Chinji horizon, Middle Miocene.

Specific Characters.—Three ridge-crests of the first superior molar, l.M^1, with strong cingulate pro-protoloph and half rudiment of tetartoloph; internal and external cones ptychoid on outer faces and on inner worn surfaces; internal cones slightly anterior to external cones, not directly opposite; median anterior and posterior trefoil conelets on either side of internal cones, less prominent trefoil conelets on either side of external cones, summits of transverse crests divided into four to five separate conelets.

Synconolophus ptychodus is smaller, more primitive, with more transversely placed cones and fewer intermediate trefoil conelets in the valleys than in its highly specialized successor *S. dhokpathanensis;* included for the present within this single species are three ascending mutations, namely, two very small and simple grinders (Amer. Mus. 19638*a*, *b*), from 400 feet above the base of the Lower Siwaliks, the larger and more complex type molars (Amer. Mus. 19442) from 800 feet above the base of the Lower Siwaliks, and finally the still more progressive grinder, an l.M^2 (Amer. Mus. 19595), from 2,000 feet above the base of the Lower Siwaliks, all from the Lower Chinji level of Pilgrim. Referable to this larger stage, but also recorded as having been found 400 feet above the base of the Lower Siwaliks, is an l.M$_3$ (Amer. Mus. 19628). From a still higher level than the Lower Chinji horizon, 1,000 feet *below* the Bhandar Bone-bed, is another l.M$_3$ (Amer. Mus. 19533).

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Synconolophus propathanensis, new species

Type.—Amer. Mus. 19487. A large and finely preserved tuskless lower jaw containing both pairs of inferior grinders, M$_2$, M$_3$. Measurements: r.M$_2$, ap. 106 mm., tr. 65 mm.; l.M$_3$, ap. 168 mm., max. tr. at tritolophid 76 mm.

Locality.—Three miles east of Dhok Pathan, India.

Horizon.—Collected in 1922 by Barnum Brown 500 feet below top of Middle Siwaliks, Dhok Pathan horizon. Lower Pliocene, (?) equivalent of Pikermi, Eppelsheim, etc.

Specific Characters.—Ridge-crests compressed, subhypsodont; deeply covered with cement; summit of crown of M$_2$ wearing into a subptychodont pattern owing to the crowding of the ridge-crest conelets and (?) conules into the valleys between the main cones; main cones directly *opposite* each other, not *alternate* as in *Synconolophus dhokpathanensis,* with two median conelets crowding anteriorly into the valleys; M_2 with 3½ ridge-crests, M_3 with ½-4-½ ridge-crests; height of tritolophid of M_3 60e mm.; the subptychoid pattern is best seen in the partly worn crown summit of M_3 which exhibits on the tritolophid and rudimentary tetartolophid a group of seven closely compressed conelets with crenulate borders; were it not for the directly opposite condition of the outer conelets, this grinder, M_3 (ridge-crests ½-4-½), might readily be mistaken for that of *S. dhokpathanensis* (ridge-crests 5½), or that of *S. corrugatus* (ridge-crests 4-5½).

See Chapter XIII of the Proboscidea Memoir.

If confirmed, the downturned type jaw of *Synconolophus propathanensis* will afford the mandibular characters of the genus *Synconolophus*, namely, as possessing a relatively elongate, downturned, tuskless, deflected rostrum, as compared with the abbreviate rostrum of *Anancus*. The ridge formula ($M\ 3\ \frac{}{\frac{1}{2}\text{-}4\text{-}\frac{1}{2}}$) is more primitive than that of *S. dhokpathanensis* ($M\ 3\ \frac{}{5\frac{1}{2}}$).

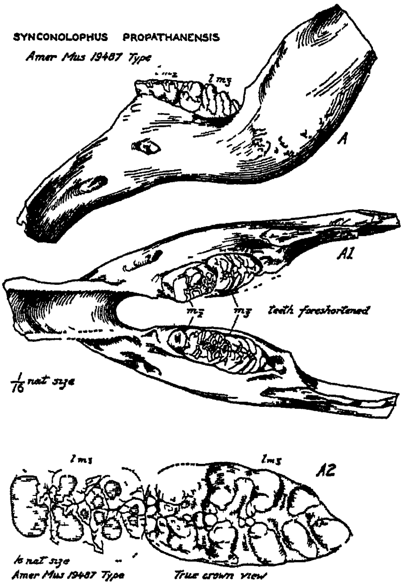

Fig. 13. A, A1, Type lower jaw of *Synconolophus propathanensis* (Amer. Mus. 19487), one-sixteenth natural size; A2, crown view of l.M_2, l.M_3, one-sixth natural size.

Subfamily: **STEGODONTINÆ**

STEGOLOPHODON NATHOTENSIS, new species

TYPE.—Amer. Mus. 19455. Posterior half of a fragmentary right third superior molar, r.M^3; posterior half of a right third inferior molar, r.M_3; and anterior half of a left second superior molar, l.M^2.

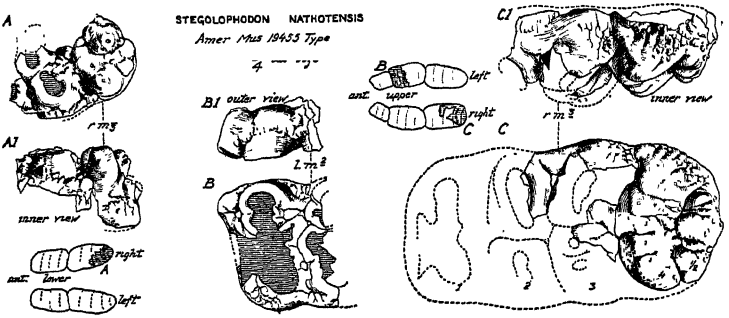

Fig. 14. Type molars of *Stegolophodon nathotensis* (Amer. Mus. 19455). One-fourth natural size.

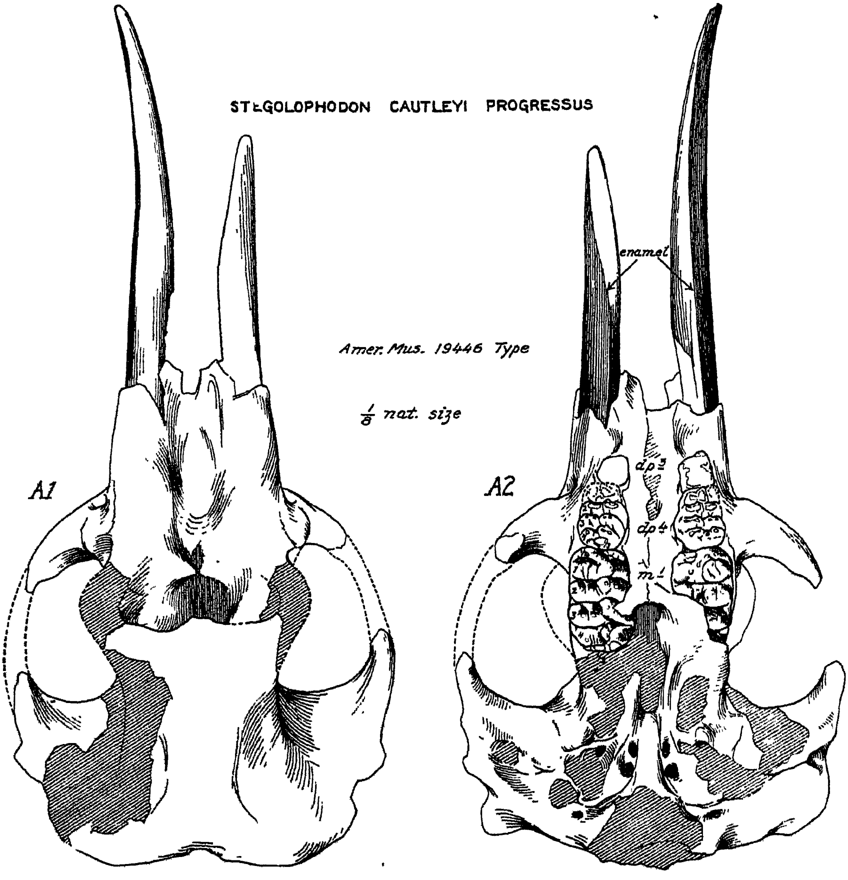

Fig. 15. Type cranium of *Stegolophodon cautleyi progressus* (Amer. Mus. 19446). One-eighth natural size.

Locality.—Collected by Barnum Brown in 1922 near Nathot, India.

Horizon.—Lower Chinji horizon, the exact level being unrecorded, lower Middle Siwaliks; Middle to Upper Miocene.

Specific Characters.—Ridge-crests low, blunted, with four to five blunted conelets on each crest; ridge-crests transversely arcuate or arched, as in *Stegolophodon stegodontoides.* Enamel thick with slightly indented border. Rugose external cingulum. Ridge-crest formula unknown, probably M 3 $\frac{?4\frac{1}{2}}{?5\frac{1}{2}}$; characters of ridge-crests and conelets quite distinct from those of *Stegolophodon latidens,* ridge-crest formula probably lower than in *S. latidens.*

See Chapter XV of the Proboscidea Memoir.

Stegolophodon cautleyi progressus, new subspecies

Type.—Amer. Mus. 19446. A juvenile cranium containing right and left superior tusks with broad enamel band, also *in situ* third and fourth superior deciduous premolars and first molar of both sides, $Dp^{3\text{-}4}$, M^1.

Locality.—Twelve miles east of Chinji Bungalow, India.

Horizon.—Collected by Barnum Brown in 1922 at summit of Lower Chinji horizon, 2,000 feet above base of Lower Siwaliks. Middle Miocene.

Specific Characters.—Superior tusks laterally compressed, with broad external enamel band; ridge-crest formula as compared with that of *Stegolophodon cautleyi*, as follows:

Stegolophodon cautleyi progressus: r.Dp 3 $\frac{3}{}$ r.Dp 4 $\frac{4\frac{1}{2}}{}$ r.M 1 $\frac{\frac{1}{2}\text{-}4\text{-}\frac{1}{2}}{}$
Stegolophodon cautleyi (typical): r.Dp 3 $\frac{?3}{}$ r.Dp 4 $\frac{\frac{1}{2}\text{-}3\text{-}\frac{1}{2}}{}$ r.M 1 $\frac{\frac{1}{2}\text{-}4\text{-}\frac{1}{2}}{}$

Four ridge-crests in intermediate molars, r.Dp^4, r.M^1, with four irregular conelets on each crest; rudimentary anterior and posterior ridge-crests in r.M^1; conelets less blunt and crowns less brachyodont than in *Stegolophodon nathotensis*, as it belongs to a more recent geologic level; median fissure in r.M^1 wanting, as shown in cotype of *Stegolophodon cautleyi,* or decidedly less distinct than in *S. cautleyi* lectotype from Perim Island; traces of irregular internal trefoil conelets on r.Dp^4 and r.M^1.

Of very great importance and interest is the presence of superior incisive tusks with lateral enamel band, as well as other evidence, in the structure of the superior grinding teeth, of the affinities of this tetralophodont type with the much more primitive trilophodont mastodonts of the Lower Miocene of France.

See Chapter XV of the Proboscidea Memoir.

This type is of great importance and interest as yielding for the first time a knowledge of the cranial structure of *Stegolophodon* in its Miocene stage of evolution.

Stegodon insignis birmanicus, new subspecies

Type.—Amer. Mus. 20002. A very large and massive left inferior jaw containing the left third inferior molar, l.M_3. Length of l.M_3 333–362 mm., breadth 97 mm., index 29–27.

Locality.—Mingoon, opposite Mandalay, Burma.

Horizon.—Collected by Barnum Brown in 1922 in the upper levels of the Irrawaddy Series, Upper Pliocene.

Specific Characters.—The ridge-crests of l.M_3, namely, $\overline{12\text{-}\frac{1}{2}}$, are the same in number as in *Stegodon insignis*, but the elongation of this inferior molar and the open character of the ridge-crests are quite distinctive from *S. insignis;* the jaw is more massive and the inferior grinding teeth surpass in length measurement those of any other stegodont type known; the grinders are larger and exhibit fewer conelets. The conelets are stout and vary in number from four to twelve on each ridge-crest. Cement is present all the way back.

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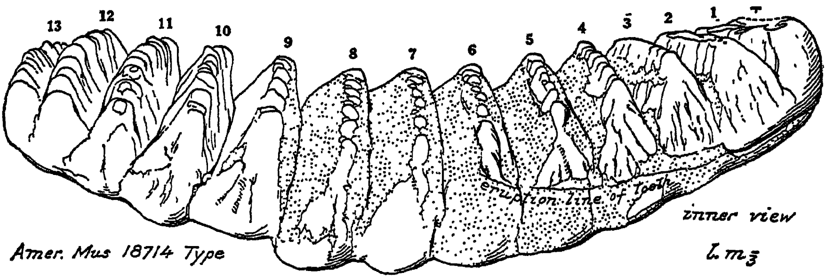
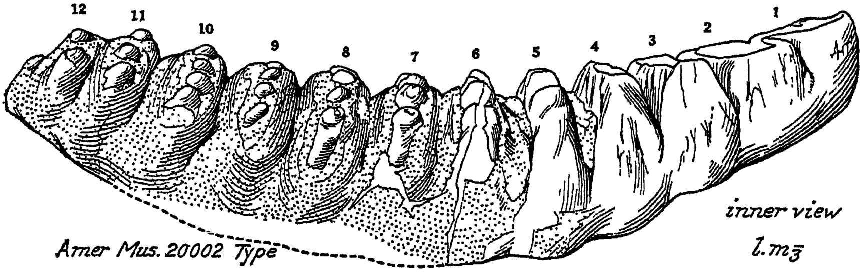


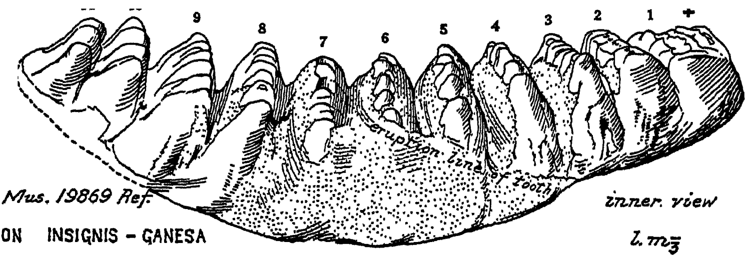
Amer. Mus 18714 Type

STEGODON ORIENTALIS GRANGERI



Amer Mus. 20002 Type

STEGODON INSIGNIS BIRMANICUS



Amer. Mus. 19869 Ref.

STEGODON INSIGNIS - GANESA

Fig. 16. *Stegolophodon orientalis grangeri* type (Amer. Mus. 18714); *Stegodon insignis birmanicus* type (Amer. Mus. 20002); *Stegodon insignis-ganesa* ref. (Amer. Mus. 19869). One-third natural size.

Stegodon orientalis grangeri, new subspecies

Type.—Amer. Mus. 18714. A third left superior molar, l.M^3, and a third left inferior molar, l.M$_3$, of the same individual.

Locality.—Part of the Granger Collection from Yen-ching-kao, near Wanhsien, Province of Sze-chuan, China, made during the winter of 1920–1921.

Horizon.—Upper Pliocene.

Specific Characters.—The subspecies *Stegodon orientalis grangeri* is more primitive than the type of *S. orientalis*, which is also from a cave in Sze-chuan; the ridge-crests are less elevated and wider apart at the base and seem to be even more primitive than those of the *S. insignis* type; the cranium is much smaller and simpler than that of *S. insignis-ganesa* and resembles in its contour rather that of *S. bombifrons*.

See Chapter XV of the Proboscidea Memoir.

Aside from the type there is very abundant referred material from the same locality, including the complete superior and inferior dentition, Dp 2-Dp 4, M 1-M 3, in various stages of attrition and dental succession, constituting the most complete material of dental succession known in the fossil Proboscidea.

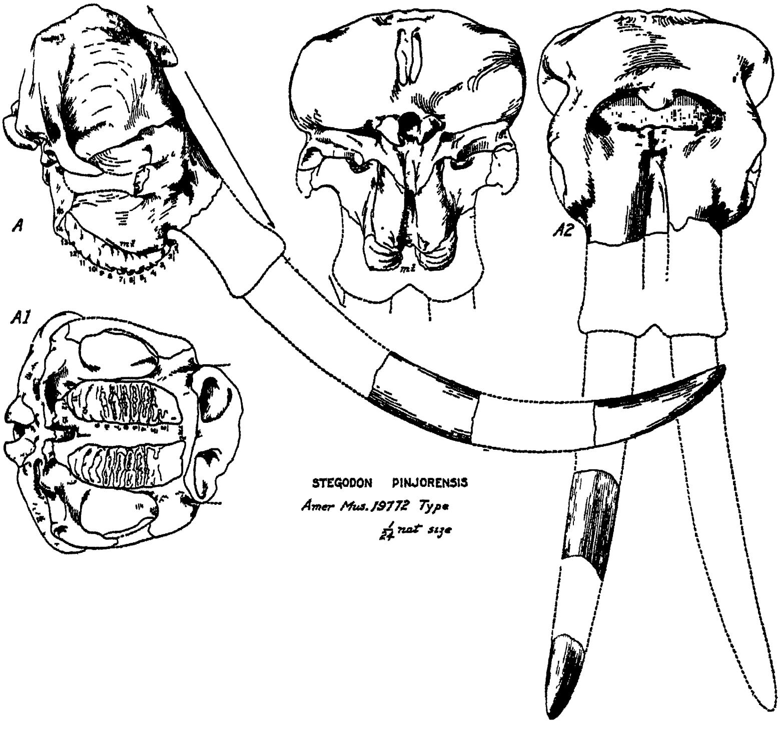


Fig. 17. Type of *Stegodon pinjorensis* (Amer. Mus. 19772). One twenty-fourth natural size.

Stegodon pinjorensis, new species

Type.—Amer. Mus. 19772. A male cranium, rostrum wanting; portions of right inferior tusk preserved.

Locality and Horizon.—Recorded by Barnum Brown as follows: "Skull. Just below Conglomerate beds, Upper Siwaliks, three miles north of Siswan, India." This progressive cranium does not belong in the Pinjor (Upper Pliocene) horizon, as the specific name *pinjorensis* suggests, but was probably deposited from the overlying Boulder Conglomerate beds of Lower Pleistocene age.

Specific Characters.—Superior grinding teeth distinguished from those of *Stegodon insignis-ganesa* by their superior size, much more numerous ridge-crests, progressive hypsodonty; the comparative ridge formulæ of M 3 are as follows:

Stegodon pinjorensis: $M\ 3\ \frac{14\frac{1}{2}\text{-}15}{}$
Stegodon insignis birmanicus: $M\ 3\ \frac{}{12\text{-}\frac{1}{2}}$
Stegodon insignis-ganesa: $M\ 3\ \frac{\frac{1}{2}\text{-}11\text{-}\frac{1}{2}}{12\frac{1}{2}\text{-}13}$

This type male cranium resembles that of the male type of *Stegodon ganesa* Falc., namely, with small rounded parieto-occipital crest, lofty and greatly abbreviated frontonasal surface, anterior nares correspondingly elevated, grinding surface of the large molars very strongly arched, but the cranium is relatively more depressed or bathycephalic than in *S. ganesa.*

See Chapter XV of the Proboscidea Memoir.

Subfamily: **Mammontinæ**

Archidiskodon sonoriensis, new species

Type.—Amer. Mus. 22637. Nearly complete skeleton, of which the palate with third superior molar, M^3, of both sides, right lower jaw (lacking ascending ramus), with third inferior molar, r.M_3, *in situ*, also symphysis, are in the American Museum.

Locality.—One mile east of Arizpe, northern Sonora, Mexico, on the Sonora River, 60 miles southeast of Cananea and approximately 100 miles north of La Prietas and San José de Pimas.

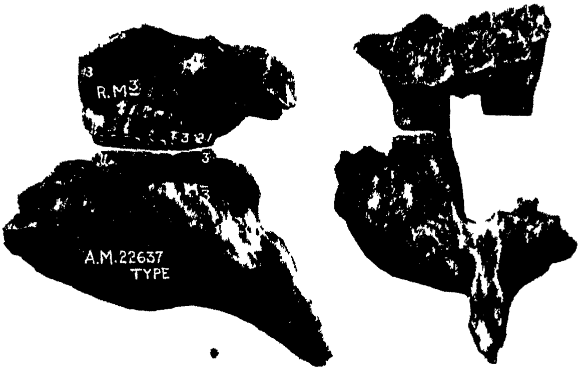
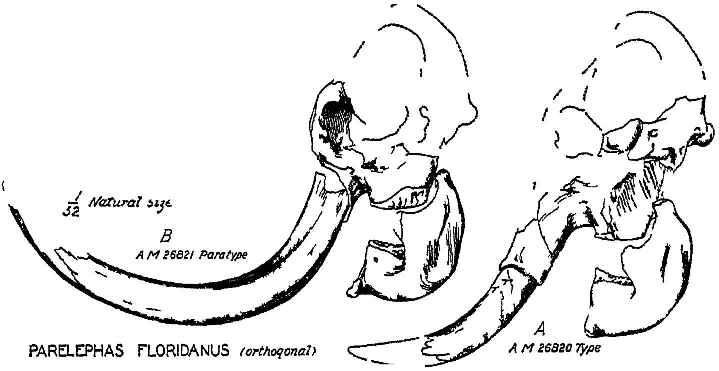
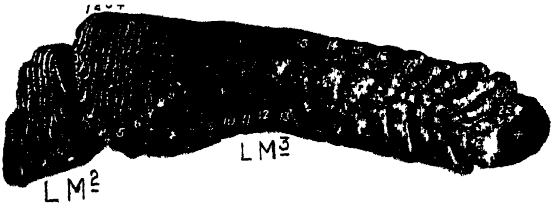


Fig. 18. *Archidiskodon sonoriensis*, anterior portion of type mandible and maxilla showing r.M^3, r.M_3 (Amer. Mus. 22637). One-twelfth natural size.





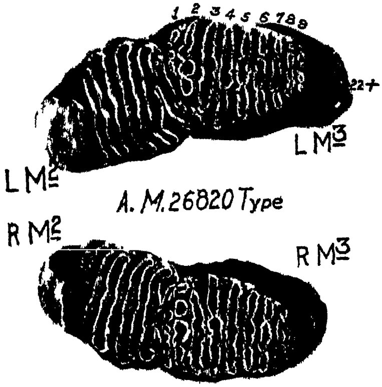
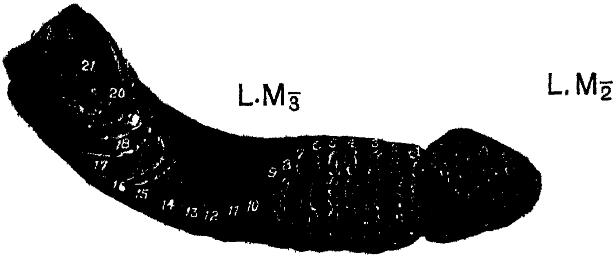


Fig 19 Type and paratype of *Parelephas floridanus* (Amer Mus 26820, 26821) Crania one thirty-second natural size, type dentition one-sixth natural size



Horizon.—The Arizpe horizon is regarded by Barnum Brown as Lower Pleistocene (lake deposit).

Specific Characters.—Mandibular rostrum prolonged obliquely downwards, with downturned beak, as seen both in front and side views; length from symphysial groove to tip of rostrum 230 mm., exposed length of M^3 246 mm., of M_3 346 mm.; depth from third unbroken plate to bottom of jaw 244 mm. A total of 11+ 2 (?) exposed ridge-plates in M^3, of 2 (?)+11+3 in M_3.

See Chapter XVI of the Proboscidea Memoir.

Parelephas floridanus, new species

Type.—Amer. Mus. 26820. Anterior portion of cranium, maxilla with M^2, M^3 of both sides, and tusks, together with lower jaw, M_2 of both sides *in situ*, of a middle-aged individual; also associated (?) right femur and other skeletal parts.

Paratypes.—Amer. Mus. 26821, adult jaw with M_2, M_3 in place, and Amer. Mus. 26822, fragment of palate with M^3 of both sides; also associated (?) left femur and other members of vertebral skeleton of an individual of larger size (Amer. Mus. 26821).

Locality.—Manatee County, Florida, two miles south of Bradenton. Discoverer of deposit and of paratype palate (Amer. Mus. 26822), J. E. Moore of Sarasota, Florida, in February of 1929; discoverer of type cranium and other material, Carl Sorensen of the American Museum, member of the Holmes Florida Expedition, in spring (March 2 to April 2) of 1929.

Horizon.—Fluviatile fine sand, (?) Upper Pleistocene.

Specific Characters.—Superior and inferior ridge-plate formula: M 3 $\frac{22+}{21+}$, max. $\frac{23}{23}$, intermediate between *Parelephas columbi* ($\frac{19}{16}+$) and *P. jeffersonii* ($\frac{25}{24}$); ridge-plates broad and widely separated at base, more compressed at summit. Incisive tusks extremely massive and relatively short. Males attain very large size. Femora measure 1250 to 1410 mm.

See Chapter XVII of the Proboscidea Memoir.

Parelephas columbi cayennensis, new subspecies

Type.—Three and a half ridge-plates of a third right superior molar, r.M^3, collected by Captain Perret in Cayenne (French Guiana), South America, and now preserved in the Muséum d'Histoire Naturelle, Marseille, France, as No. 8449 (cast Amer. Mus. 21933).

Horizon.—Probably Upper Pleistocene.

Specific Characters.—The superior type fragments, photographs and casts of which have been kindly furnished the present writer through the courtesy of Director W. Laurent of the Muséum d'Histoire Naturelle of Marseille, and Prof. W. Repelin, Conservateur, is characterized by Professor Repelin (translation of letter of March 30, 1929) as follows: "They were in rather bad condition and so badly cemented together that I had to take away the larger part of the cement. One of these fragments, A–1, is represented in side view on one of these photographs. The lamellæ are very worn and they show the plate of blackish or brownish enamel rather in relief and the ivory forms a small median depression. The cement which separates the lamellæ is not very thick in this specimen. In the other photograph, A–2, the specimen is shown as seen from above. Finally another fragment, B, is also represented as seen from above. It has been worn in the direction of the lamellæ, but this worn part shows only a very irregular section of ivory and enamel."

The fragment consisting of three and a half lamellæ or ridge-plates is made the type of the new subspecies *Parelephas columbi cayennensis*. These ridge-plates appear to belong to the posterior portion of the crown of a third superior molar of the right side, r.M^3; they are strongly concave posteriorly and are composed of coarse enamel, deeply grooved or crenulated on the sides; the external cement, formerly present, has been dissolved or worn away; the apices of the three ridge-plates present a convex profile, hence supporting the superior molar reference indicated by the posterior concavity. They correspond broadly with ridge-plates 16, 17, and 18 of an r.M^3 of *Parelephas columbi;* in size they correspond with ridge-plates 19, 20, and 21 of *floridanus;* they seem relatively narrow, thus agreeing with the narrow ridge-plated *P. columbi* rather than with the broad-plated *Archidiskodon imperator*.

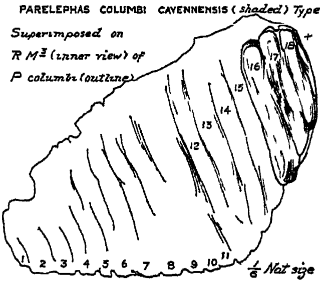


Fig. 20. Type (shaded) of *Parelephas columbi cayennensis* (Marseille Mus. 8449) placed upon outline of complete r.M^3 of *Parelephas columbi*. One-sixth natural size.

See Chapter XVII of the Proboscidea Memoir.

Subfamily: **ELEPHANTINÆ**

ELEPHAS PLATYCEPHALUS, new species

TYPE.—Amer. Mus. 19818. Cranium with M^3 of both sides partly exposed.

LOCALITY.—Near Siswan, bed of Amilee Creek, Simla Hills, India.

HORIZON.—Found in separate mass of consolidated gravel which had apparently been washed down from an original Boulder Conglomerate bed into a shallow region bordering Amilee Creek. While not found *in situ*, it would seem to be of the same Lower Pleistocene age as the Boulder Conglomerate formation above. Barnum Brown Collection of 1922.

SPECIFIC CHARACTERS.—Cranium of very primitive elephantine affinity, low, flattened; orbit widely separated from occiput; premaxillary rostrum somewhat broadened, resembling that of *Elephas;* posterior nares deeply indented; occipital condyles on relatively low plane, not greatly elevated above grinders; relatively long and narrow cranial proportions. Cranium widely different from the elevated *Elephas hysudricus* or the greatly elevated *Elephas indicus* crania. Ridge-plates of type molars fractured or absent. Estimated ridge-plate formula: M 3 $\frac{16\frac{1}{2}}{}$.

See Chapter XX of the Proboscidea Memoir.

The discovery by Barnum Brown of this type below the Boulder Conglomerate renders it probable that *Elephas platycephalus* is of Lower

Pleistocene or possibly Upper Pliocene age, in its dolichocephalic proportions it appears to be even more primitive than the *Archidiskodon planifrons* cranium of Upper Pliocene age

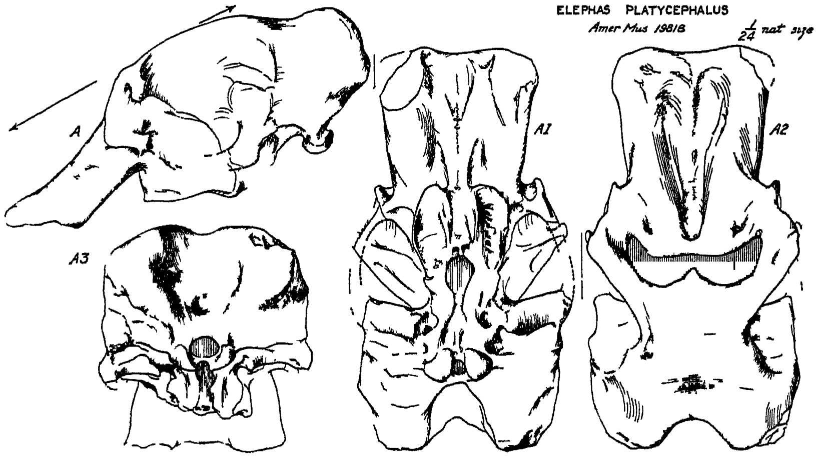


Fig 21 Type cranium of *Elephas platycephalus* (Amer Mus 19818) One twenty-fourth natural size

ELEPHAS PLATYCEPHALUS ANGUSTIDENS, new subspecies

TYPE —Amer Mus 19915 Third inferior molar of the left side, l M_3

LOCALITY —Three miles west of Chandigarh, Siwalik Hills, India

HORIZON —Collected by Barnum Brown in 1922 "below Conglomerates," Upper Siwaliks

SPECIFIC CHARACTERS —Inferior molars relatively long and narrow, with parallel ridge-plates of moderate height, very little cement, and terminating superiorly in four conelets on ridge-plates 7–14 and four to five conelets on ridge-plates 1–6 This conelet disposition is very similar to that observed in crown view of the grinders of *Elephas hysudricus* Ridge-plate formula of l M 3 $\overline{1\tfrac{1}{2}-1\ 2-1\tfrac{1}{2}}$, a total of fourteen more or less elevated and compressed ridge-plates

See Chapter XX of the Proboscidea Memoir

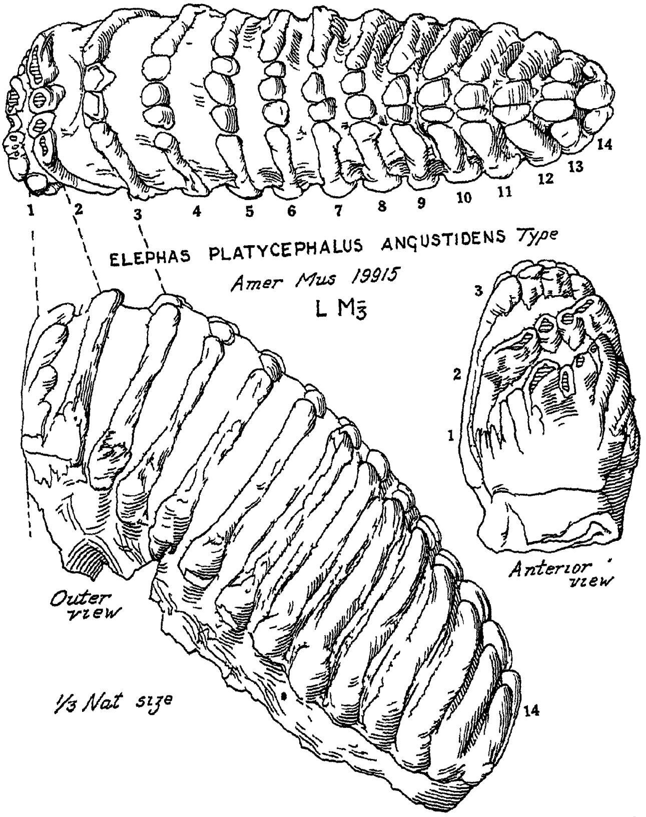


Fig 22 Type l M_3 of *Elephas platycephalus angustidens* (Amer Mus 19915) One-third natural size

AMERICAN MUSEUM NOVITATES

Number 394
Published by
The American Museum of Natural History
New York City
Dec. 26, 1929

551, 783 (51.7)

PLIOCENE BEDS OF THE IREN GOBI[1]

By L. Erskine Spock

INTRODUCTION[2]

The purpose of this paper is to place on record the finding of Pliocene strata containing a rich and varied vertebrate fauna in the eastern part of the Iren Tala of Mongolia by the Central Asiatic Expedition of the American Museum of Natural History in 1928. Pliocene beds had already been described by P. Teilhard de Chardin[3] in the region of Dalai Nor, and in Southern Inner Mongolia by Andersson,[4] but their existence in Central Mongolia had not been known previously. In 1922 the name Hung Kureh[5] was applied by the members of the expedition to fossiliferous beds of Pliocene age discovered at the base of the Baga Bogdo, in the Altai region of Western Mongolia.

During the 1928 field season, the Central Asiatic Expedition spent in all several weeks exploring the country which lies east of the main Kalgan-Urga trail. The region had never been visited before by the Expedition and was first crossed in June by a reconnaissance party in search of new fossil fields. On the second day of this exploration (June 19), vertebrate remains were found near Gur Tung Khara Usu (Fig. 1) in more than sufficient abundance to justify detailed investigation by the entire Expedition. Later in the season, during July and August, the country was explored more carefully and many fossils were collected.

The Iren Gobi

In the central part of the Iren Tala,[6] the lowest region of the Gobi desert, there extends a wide area of the "later sediments," covering several thousand square miles. For this great basin the name Iren Gobi is here suggested, the name being taken from Iren Dabasu, the first discovered of many fossil fields which have been examined by the Central Asiatic Expeditions within the borders of the basin. The sediments, nowhere believed to be more than 1,000 ft. thick, occupy a broad shallow depression formed by the downwarping of the ancient deformed and peneplaned rocks which comprise the desert floor.[1] The peneplane surface on which the sediments rest was formed in pre-Cretaceous time; the basin-warping began in the Cretaceous period and presumably has been active in an intermittent fashion through most of the time which has elapsed since the initial warping. Iren Gobi sediments do not present a complete succession of strata, but have been deposited and eroded in response to changes produced by differential warping and fluctuations in climatic environment. The Eocene and Pliocene are well represented by both sediments and fossils. The Cretaceous and Oligocene beds contain a rich fauna but are restricted in thickness. Miocene beds have not yet been discovered and the Pleistocene record is but poorly preserved.

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[1] Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 96.

[2] The general geologic setting of Mongolia and the methods of study which served as a basis for the present work have already been described. Berkey, C. P., and Morris, F. K. 1927. "Geology of Mongolia," Natural History of Central Asia, Vol. II.

[3] Teilhard de Chardin, P. 1926. 'Etude Géologique sur la region du Dalai-Noor.' Mém. de la Soc. Géol. de France, No. 7.

[4] Andersson, J. G. 1923. 'Essays on the Cenozoic of Northern China.' Mem. Geol. Survey of China, Series A, No. 3, pp. 36–52.

[5] Berkey, C. P., and Morris, F. K. 1927. 'Geology of Mongolia.' Natural History of Central Asia, Vol. II, pp. 233–236, 365–366.

[6] Berkey, C. P., and Morris, F. K. 1927. 'Geology of Mongolia.' Natural History of Central Asia, Vol. II, pp. 206, 207.

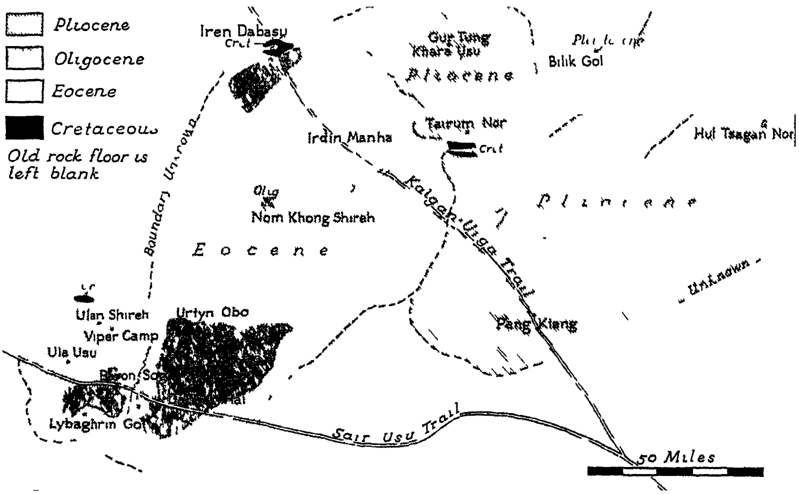

Fig. 1. Sketch map of the Iren Gobi showing principal fossil localities. Contacts shown by broken lines are inferred and subject to correction.

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[1] Berkey, C P, and Morris, F K 1924 'Basin Structures in Mongolia.' Bull Amer Mus Natural History, Vol LI, Art V, pp 103–127.

The outline of the Iren Gobi is roughly elliptical, with its longer axis trending NE-SW in parallel alignment with the main structure lines of this part of Asia. In crossing the desert by the Kalgan-Urga trail, Iren Gobi sediments are first encountered at P'ang Kiang,[1] from which place they continue northward to Iren Dabasu with only minor local interruptions.

The western and central parts of the area in question are fairly well known, and have been studied by members of the Expedition during all four field seasons (1922–3–5–8). Strata of Cretaceous, Eocene and Oligocene age were recognized in 1922[2] and have yielded large collections of fossils. Recent exploratory traverses indicate that these fossil localities and their surrounding sediment are to be considered part of the same basin and continuous in a geographic sense with the Pliocene strata of the eastern part of the Iren Gobi.

PLIOCENE SEDIMENTS

Pliocene sediments are spread over the eastern and northeastern area of the Iren Gobi. Since the eastern margin of the Iren Gobi has not been seen by the Expedition, the boundaries of the Pliocene cannot yet be determined; nevertheless sediments of this age are known to occupy several thousand square miles. They differ materially from the Cretaceous and earlier Tertiary sediments in being largely of lacustrine origin. This is essentially the condition in the eastern part of the area, centering about the lake district of Ungur Tsagan Nor. To the west and south, notably at P'ang Kiang, most of the Pliocene deposits are stream-laid and closely resemble the earlier, better-known Tertiary strata. The lacustrine and fluvial beds grade into each other laterally with an imbricating and mutually overlapping contact which may well be attributed to the fluctuating size of the lakes in which the sediments of the eastern area were laid down. Apparently the Pliocene climate was characterized by marked changes in rainfall. It is worthy of note that fossils have been discovered only where there is an alternation of stream and lake deposits, and no organic remains have yet been found where there is an uninterrupted sequence of beds of the same origin. From this mode of distribution and from other supporting evidence, the fauna is believed to have had a lake-shore habitat. The lacustrine deposits consist of light-colored (white, gray and buff) sands and clays with considerable marly limestone. The fluvial material is commonly coarse gravel and brick-colored silts and clays. In the northwest, the Pliocene is underlain by Eocene beds; elsewhere it rests directly on the pre-Cretaceous peneplane developed on the ancient rocks.

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[1] Berkey, C. P., and Morris, F. K. 1927. 'Geology of Mongolia.' Natural History of Central Asia, Vol. II, pp. 52–55.

[2] Granger, Walter, and Berkey, C. P. 1922. 'Discovery of Cretaceous and Older Tertiary Strata in Mongolia.' American Museum Novitates, No. 42.

Berkey, C. P., and Granger, Walter. 1923. 'Later Sediments of the Desert Basins of Central Mongolia.' American Museum Novitates, No. 17.

Berkey, C. P., and Morris, F. K. 1927. 'Geology of Mongolia.' Natural History of Central Asia, Vol. II, pp. 182–183, 196–212, 355, 359–362, 364.

Over large areas the Pliocene beds lie undisturbed and horizontal. They are nowhere covered by later deposits. During the formation of the Gobi erosion plane, no appreciable residual material was left as a capping, a condition in which these beds differ considerably from the earlier Tertiary and Cretaceous deposits of the Iren Gobi. Their maximum thickness is on the order of 500 ft.

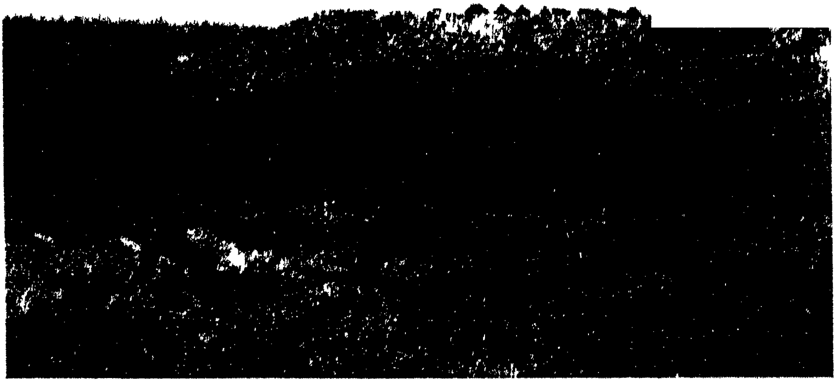

Fig. 2. Type locality of the Pliocene Tung Gur formation. The scarp in the background is formed by a layer of resistant limestone. The fossil in the foreground is a rhinoceros.

The Tung Gur Formation

The Tung Gur formation is the only Pliocene formation named during the 1928 season. Its type locality and the surrounding country form the only region yet discovered in the Iren Gobi where Pliocene fossils are both well preserved and abundant. On the scarp some three and a half miles north of the well, known as Gur Tung Khara Usu, fossils occur at several horizons, in each case embedded in a rather coarse matrix of sand. This material is in part firmly cemented and in many places highly cross-bedded. Associated beds of clay and limestone are barren. Lack of continuity and a pronounced lens-like form are the outstanding characteristics of the beds. The bivalves noted in the faunal list occur in the coarse sandstone together with the mammalian remains. The general relations of the beds and the position of the fossils are indicated in Fig. 4.

Fig. 3. Pelecypod shells in the Tung Gur formation west of Gur Tung Khara Usu.

The following is an abridged preliminary list of the fossils collected in the locality as supplied in the field by Mr. Granger:

Mastodonts[1], 2 genera, including *Amebelodon grangeri* Osborn
Canid
Rhinocerid
Cervid
Antelope cf. *Gazella*
Turtles
Pelecypods, at least three species.

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[1] Osborn, H. F. 1929. 'The Revival of Central Asiatic Life' Natural History, Vol. XXIX, No. 1, pp. 12, 15, 16.

Thirty miles to the southeast, on the lip of the great depression of Tairum Nor, the same formation is exposed on the face of a precipitous scarp (Fig. 5). Although the fossils are the same types as those discovered at Gur Tung Khara Usu, the sequence of beds in quite different. The scarp is composed largely of red clays, divided horizontally by a lens of coarse river deposits and capped by a heavy gravel member. The fossils are contained in the upper gravel and less abundantly in the clay and lower gravel, but the pelecypods so common at Gur Tung Khara Usu are absent. The same sequence of beds has been observed on the south side of the Tairum Nor depression and also farther to the east near Gosho-in-Sumu. No fossils have been obtained from the two places last mentioned, but it is not improbable that they may be found in the future, since the scarps in the general region of Tairum Nor have a total length of more than 25 miles and have not been fully prospected. Farther to the east, a few fragments of bone of sufficient diagnostic value to determine the Pliocene age were found by Mr. Granger on the Barro Unduh upland, but there was no evidence of extensive deposits of fossils. To the east and south of this point, the Pliocene consists entirely of lake-deposited sands, clays and limestones which are completely barren at the places examined by the Expedition.

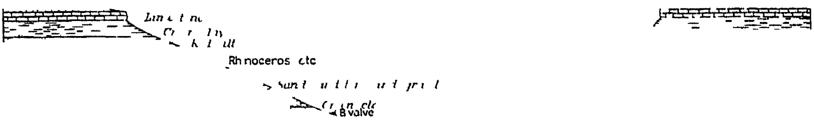

Fig 4. Section of the Tung Gur formation at the type locality.

In view of the thickness and extent of the known Pliocene deposits east of the Kalgan-Urga trail, it seems quite probable that the beds of the P'ang Kiang[1] formation may be a lateral southward continuation of the Tung Gur and associated Pliocene formations. This tentative correlation is made on structural grounds only, for as yet no diagnostic fossils have been found in the P'ang Kiang beds. This question will be taken up in a later publication.

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[1] Berkey, C P, and Morris, F K 1927, 'Geology of Mongolia' Natural History of Central Asia, Vol II, pp 52–55 and 276

LATER HISTORY

Over most of the region underlain by Pliocene deposits, the Gobi erosion plane is developed in a high stage of perfection and one may travel for many scores of miles in a straight line over monotonously level plains with seldom a break even on the horizon. The preservation of the erosion surface is remarkable in that the Pliocene uplands are not normally protected by resistant layers of cap-rock nor by the equally durable accumulations of residuary gravels which are the rule in the central and western portions of the Iren Gobi. To the west and north the beds are undergoing destruction; they are encroached upon by the constant enlargement of the inner lowland which separates them from the oldrock basin rim of the Iren Gobi, and by the equally rapid expansion of the lowland hollows of Tairum Nor and P'ang Kiang. In the easternmost part of the region seen by the expedition, the surface is pitted by a great group of depressions forming the lake district of Ungur Tsagan Nor.

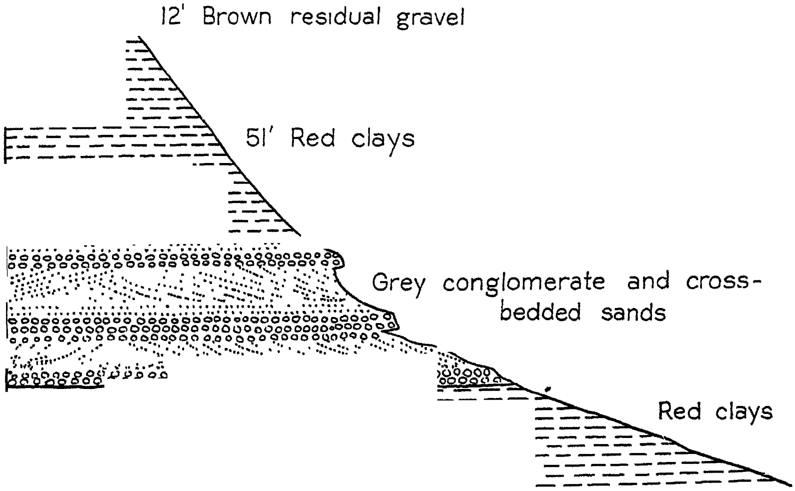

12' Brown residual gravel
51' Red clays
Grey conglomerate and cross-bedded sands
Red clays

Fig. 5. Section of the Tung Gur formation on the north side of the Tairum Nor depression.

The lake bottoms commonly occur at elevations from three to four hundred feet below the surface of the Gobi erosion plane; the slopes which separate the lake bottoms from the upland are cut into steps by a complicated series of lake terraces (Fig. 6). Here is a record of Pleistocene history which clearly demonstrates the changing climate; each lower terrace indicates not only a break in the amount of moisture, but a break which, if the record is interpreted correctly, points to increasing aridity. The lake basins are cut in lacustrine deposits; the lakes of the Pliocene time extended westward to Gur Tung Khara Usu and covered many hundreds of square miles; now they are diminished to playas and are in danger of being buried by the sands.

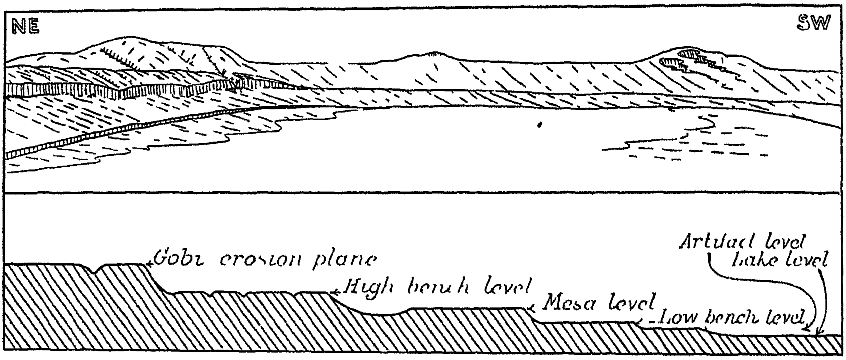


Fig. 6. Sketch of Ungur Tsagan Nor and profile of lake terraces. The upper level is the Gobi erosion plane, a feature probably developed in early Pleistocene time.

AMERICAN MUSEUM NOVITATES

Number 395 Published by
THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City Dec. 31, 1929

56 9, 72 P

PROHYRACODON ORIENTALE KOCH, THE OLDEST KNOWN TRUE RHINOCEROS

BY HORACE ELMER WOOD, II

The evolutionary significance of *Prohyracodon orientale* Koch (not to be confused with *Prothyracodon* Scott and Osborn), an Eocene true rhinoceros, has usually been overlooked. The only known material is from Eocene variegated clays of Transylvania (formerly Hungarian, now Rumanian territory). This neglect has been caused partly by its being represented only by fragmentary material in the somewhat isolated University of Cluj, and more by Koch's indistinct figures (1897), on which Abel (1910) based his slightly less satisfactory composite figure. In addition, there has been skepticism as to the extreme antiquity assigned to it. Koch, as indicated by his unfortunate name, considered the cursorial rhinoceros *Hyracodon* (Hyracodontidæ) its closest relative, though he also saw resemblances to *Aceratherium occidentale* and *Hyrachyus*. Abel, however, referred it correctly to the true rhinoceroses. While studying the earlier European fossil rhinoceroses, in the various European museums, I was permitted, through the courtesy of Professors Voitesti, Stanciu, and Mateescu, to restudy Koch's types, and was enabled to obtain one of the third upper molars by exchange (that shown by Koch, 1897, Pl. XII, fig. 2). It is now No. 21935 in the American Museum of Natural History (Fig. 5). This present study was originally included in the scope of a projected paper on the evolutionary lines of European rhinoceroses in general, but the considerable delay, before the remainder of the material will be in final shape for publication, makes it seem desirable to excerpt the data relating to *Prohyracodon*, making it generally available through separate publication. I wish to acknowledge the kindness of Dr. Florence Dowden Wood, who subordinated her own interests, during most of this trip, to act as my artist.

Koch collected the specimens about 1882 under the auspices of the Siebenbürgisches Museum, a Magyar learned society of Klausenburg. As yet this society has no building of its own, so the specimens are distributed, for the present, through the appropriate University collections. Fossils are in the Geological and Mineralogical Institute of the

University of Cluj. There is no relationship with the Siebenbürgisches Museum at Hermannstadt (=Sibiŭ), which is a general museum under Saxon auspices. The Oligocene rhinoceros, from a higher level, which Koch (1911) figured as "*Præaceratherium minus*" (actually *Ronzotherium* [=*Paracænopus*] *filholi*), as well as the types of *Prohyracodon orientale* Koch (1897), are in Cluj. The type of the early titanothere, *Brachydiastematherium transsylvanicum*, from the same level, is at Budapest, however, in the Museum of the Hungarian Geological Survey. There are only a few fragments at Cluj which were found later by Koch. Koch's locality is a ravine beside Andrashaza Hill near the town of Mera, a few kilometers west of the city of Cluj (otherwise known as Klausenburg, in German, and Kolozsvâr, in Magyar). The locality can be seen from the train window, to the north of the Budapest-Cluj line.

The geologic age of its horizon (Koch's Obere bunte Tonschichten) has been a subject of dispute. Koch (1894) described the stratigraphy of these beds in detail, giving extensive faunal lists for the various fossiliferous levels. He discussed the discovery of this rhinoceros-like form, which he compared to *Quercytherium* Filhol. *Prohyracodon orientale* and the peculiar titanothere, *Brachydiastematherium transsylvanicum* Böckh and Matyasovszky are the only mammals known from this horizon, which is, however, preceded and followed by marine invertebrate faunas in the Untere and Obere Grobkalkschichten. Koch interpreted its age as Middle Eocene, as he regarded both marine faunas as Middle Eocene. Stehlin (1903) doubted this on the basis of the progressiveness of *Prohyracodon*, and suggested the Oligocene as more reasonable, as did Matthew (1915). Abel, in his redescription of *Prohyracodon* (1910), illustrated with a composite of Koch's figures, reserved final judgment as to the age, though inclined to accept Koch's interpretation. The Hungarian Geological Survey informs me (letter, 1925) that, so far as they know, Koch's age determination is still valid, and Professor Mateescu, of the University of Cluj, who is making a careful study of the stratigraphy of the whole region, informs me in a letter dated August 12, 1928, that "So far, according to my results, I can not say otherwise than that the variegated beds of Andrashaza (Mera) belong to the Middle Eocene-Auversian." On this basis, then, *Prohyracodon* would be roughly equivalent in age to the Bridger of Wyoming, and would be at least as old as the oldest known American true rhinoceros (*Eotrigonias petersoni* Wood, 1927), and exceeded in age, among known rhinocerotoids, only by the Lost Cabin (Lower Eocene) representative of *Hyrachyus*. Certainly in view of the extensive invertebrate faunas above and below, there is not much likelihood that its age has been seriously misjudged.

In addition to teeth, various associated rhinocerotoid leg bones, presumably of the same species, were collected. The following teeth were present: two isolated RM^{3}s (Fig. 5); part of a right maxillary with broken M^3, and another part with broken M$^{1\text{-}2}$ (Fig. 4); a left maxillary with M^3, broken M^2, roots of M^1 and place for P^4 (Fig. 3), also the associated LP^4 (Fig. 2) and a LP^3, isolated (Fig. 1). The three RM^{3}s show the presence of at least three individuals, all young mature to mature. To avoid any possible future difficulties, I hereby select, as lectoholotype, the left maxilla with M$^{2\text{-}3}$ on which P^4 seems to fit and with which it is almost certainly associated, and P^3 very probably (Figs. 1–3). Koch's first discussion (other than casual mention) of this material (1894) indicates that the five left cheek-teeth (P^3-M^3) belong together, that the right molars (M$^{1\text{-}3}$) also belong together, and that all these teeth were found at the same time, the isolated M^{3}s being found later. The right molars may well be associated with the left cheek-teeth, as they show about the same degree of wear. The other original cotypes then become lectoparatypes.

Koch's figures, though accurate enough, are indistinct, and do not represent the specimen satisfactorily, except to one who has already seen it. By cleaning the remaining matrix from LP^3, LP^4, RM$^{1\text{-}2}$, and LM$^{2\text{-}3}$, I exposed various additional characters for the first time. These characters are indicated in figures 1–5, on which it is now possible to base a more accurate composite drawing (Fig. 6).

The animal is a true rhinoceros, of the "American" type, that is, the molar protocones are not constricted off from the protoconules as in most European rhinoceroses. It is primitive compared with most forms, but not extraordinarily so. The teeth are a little smaller than those of *Eotrigonias rhinocerinus.* The parastyles of P^3, P^4 and M^3 (the only teeth in which they are preserved) are of normal rhinocerine proportions and are plastered against the paracones. The premolars are primitive, with the median valley opening to the rear, and are already more advanced than in *Eotrigonias rhinocerinus* from the Uinta, since the metalophs are already rather prominent. These teeth are roughly comparable in evolutionary stage with the more primitive species of *Trigonias* and of *Cænopus* from the American Oligocene. The third upper molar has already lost all but a trace of the posterior buttress, and is more progressive than in some later rhinoceroses.

P^3 (Fig. 1) is subquadrate. The hypocone is incipiently defined from the protocone by grooves on both slopes of the ridge. The dentine of the protoloph has not yet become confluent with that of the ectoloph at this stage of wear. The internal swell of the paracone may be called a crista, or not, according to taste. The long metaconule abuts against the buccal side of the hypocone, with only a minute "wind gap" to the rear left at this stage of wear. A groove runs down posteroexternally from it to the cingulum. A very little additional wear would have isolated the median valley as a medifossette. Slight grooves separate the parastyle, paracone, and metacone, on the outer slope of the ectoloph. There is a faint external cingulum between the paracone and metacone. Near the parastyle, the anterior cingulum seems to have been worn away by the high protoconid of P_3. From there, the cingulum swings up onto the protocone and stops. The internal cingulum starts at a level nearer the gum, and swings around to the rear of the tooth as the posterior cingulum.

1

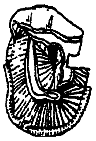


Fig. 1. *Prohyracodon orientale* Koch, left P^3, apparently associated with lectoholotype, ×1, Geol. Min. Inst., Cluj.

Measurements of Types of *Prohyracodon orientale* Koch in Cluj

	R	L
M^{1-3}, A–P	^{k}55.0	^{e}52.0
Width P^3		17.0
Length P^4		13.4
Width P^4		18.4
Length M^1		^{e}15.0
Length M^2	19.3	^{e}18.8
Length M^3	19.0	19.8
Width M^3		19.8
Length tibia	^{k}195.0	
Length radius		^{k}175.0
Length radius (second individual)		^{k}165.0

^{e} = estimated.
^{k} = fide Koch.

P^4 (Fig. 2) is much like P^3 in general plan, but is a little more differentiated. The tooth evidently erupted with the ectoloph rotated to the rear at a ninety-degree angle, and with the crown on the bias, as the ectoloph is badly worn, whereas there is progressively less wear toward the lingual side of the tooth, the protocone being absolutely unworn. In addition, there is a triangle of wear on the outer slope of the ectoloph which touches the base of the paracone and spreads out over the metacone, and which, obviously, could not have developed with normal occlusion. The outline of P^4 is typical of a primitive rhinoceros, being rounded postero-internally, so that its shape is between subtriangular and subquadrate. The protoloph originally projected higher than the metaloph. An incipient hypocone is demarcated from the protocone, very slightly on the internal slope of the protoloph, and more definitely on the external slope. A crista is present. The metaconule forks internally, one fork abutting against the "hypocone," and the other pointing postero-internally. The anterior fork closes the median valley high up (3.5 mm. above the deepest part of the medifossette pit). The "wind gap" which is left leading from the median valley to the rear is about 2.5 mm. deep. From the "wind gap" a deep groove runs down toward the cingulum and disappears in a slight pit, opposite the end of the posterior fork of the metaconule. The medifossette is very deep, and a moderate postfossette is present. The parastyle, paracone and metacone are defined by slight grooves on the external slope of the ectoloph. A trace of an external cingulum appears on the rear of the metacone. There is a slight accessory cingulum on the anterior of the parastyle, near the base. The anterior cingulum, after forming a hump nearly opposite the protoconule, rises and ends against the sharp, nearly right angle, formed by the curve of the protoloph. The internal cingulum starts at the other side of this angle, and after rising into the usual hummock at the posterointernal corner of the tooth, continues as the posterior cingulum.

2

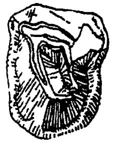
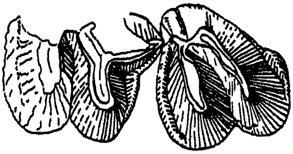


Fig. 2. *Prohyracodon orientale* Koch, left P^4, almost certainly associated with lectoholotype, ×1, Geol. Min. Inst., Cluj.

3



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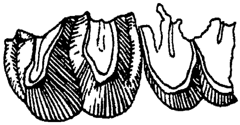

Fig. 3. *Prohyracodon orientale* Koch, left M^{2-3}. lectoholotype, ×1, Geol. Min. Inst., Cluj.

Fig. 4. *Prohyracodon orientale* Koch, right M^{1-2}, perhaps associated with lectoholotype, ×1, Geol. Min. Inst., Cluj.

No characters of M^1 can be deciphered, except the absence of any internal cingulum (Fig. 4).

M^2 is a typical primitive rhinoceros molar, of the American type (Figs. 3–4). The protocone is slightly defined posteriorly by a groove, adjoining which is a slight antecrochet. There is no crista. There is no internal cingulum, but anterior and posterior cingula are present.

All four M^3s are strikingly alike (Figs. 3 and 5). They are all triangular. At their several stages of wear, the dentine of the protoloph is confluent with that of the ectoloph on one tooth, obscured in one by a break, and not yet confluent in the other two. The protocone is not demarcated at all. A slight antecrochet is present. The parastyle is of normal rhinocerine type, with a sharp antero-exterior angle, and a very slight cingulum down the edge. Three of these teeth have a faint trace of a posterior buttress, which is absent altogether on the fourth (Fig. 3, Koch 1897). There is an anterior cingulum, a weak internal cingulum across the median valley, and a posterior cingulum which rises into a pronounced cuspule at the postero-external corner of the tooth. From here a very tenuous external cingulum continues nearly to the paracone.

5

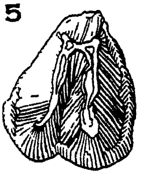

Fig. 5. *Prohyracodon orientale* Koch, right M^3, lectoparatype, ×1, Amer. Mus. Nat. Hist. No. 21935.

M^3 is somewhat suggestive of *Epitriplopus uintensis* (Peterson); the other teeth—P^{3-4} and M^2—are totally different. It seems highly improbable that the Cluj species is closely related to any hyracodont; it suggests the upper Oligocene *Meninatherium telleri* of eastern Carniola (formerly in Austria, now in Jugo-Slavia), as Abel pointed out, and *Eotrigonias rhinocerinus* of Utah (Wood, 1927), among animals of comparable size. It is not close to *Cænolophus* or to *Ardynia* of Mongolia, or to any of the Hyrachyidæ.

6

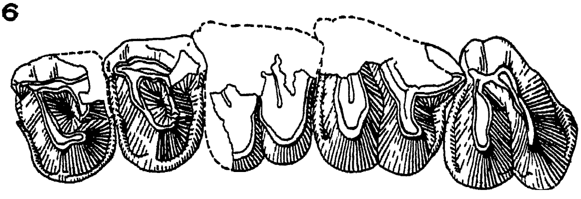

Fig. 6. *Prohyracodon orientale* Koch, left P^3–M^3, ×1, composite.

From a morphological viewpoint, it is more suggestive of the American rhinoceroses than of the later typical European forms. Perhaps the closest comparison is with *Eotrigonias rhinocerinus*, and after that, with *Meninatherium telleri*, but the genus *Prohyracodon* is isolated at present, both in time and in space. Its Eocene age and morphological progressiveness suggest strongly that the common ancestor of all lines of rhinoceroses and near-rhinoceroses must be looked for in formations not younger than Lower Eocene, and possibly as old as the Paleocene.

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AMERICAN MUSEUM NOVITATES

Number 396 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Jan. 9, 1930

59.79 E:11.492

THE INDUCTION OF EGG-LAYING IN THE SALAMANDER, *EURYCEA BISLINEATA*, BY PITUITARY TRANSPLANTS

BY G. K. NOBLE AND L. B. RICHARDS

It has been established by Smith (1926, 1927), Smith and Engle (1927), Zondek and Aschheim (1927) that frequent transplants of the pars anterior of the pituitary induce a precocious sexual maturity in rats and mice. However, Riddle and Flemion (1928) found that similar treatment with daily homeotransplants of anterior pituitary in doves had only a slight effect on the female reproductive cycle. Wolf (1929) showed that the common frog, *Rana pipiens*, could be induced to lay its eggs in November by transplanting fresh anterior lobe substance into its lymph sacs on several successive days. Daily transplants also induced sexual activity in the male Wolf (1929*a*) was able to induce egg-laying and fertilization in this frog in the latter part of October, several months before the normal breeding season.

The present paper represents a preliminary report of a study of the effect of anterior pituitary transplants on ovulation in salamanders. In brief, we find that anterior pituitary transplants have the same effect in salamanders as Wolf reported in frogs. The species which we selected for this work is the common two-lined salamander, *Eurycea bislineata* (Green), a species which breeds in May and June (Dunn, 1926). The experiments were carried on during November, December and January, with material freshly collected at Bayside, L. I. Several hundred specimens of *Eurycea bislineata* have been kept for varying periods during the three months in our laboratory tanks but none have ever laid their eggs spontaneously.

In operating, the pars anterior of the pituitary was removed from a freshly killed adult *Eurycea bislineata*, either male or female, and placed in .7 per cent salt solution. An adult female was chloretonized in a 1 to 2000 solution and a small slit made in the skin covering the ventral surface of the tongue musculature. The isolated pars anterior was thrust posteriorly through the slit to the vicinity of a blood vessel. The anæsthetized animal was next placed in water, a stitching of the wound being found unnecessary. The controls were treated in a similar manner, but a small piece of muscle, the same size as the pars anterior, was inserted in the lymph space underlying the tongue musculature.

Five specimens each received a single transplantation of anterior pituitary on December 28. Within two days one of this series laid 24, another 25, another 36, and another 3 eggs. None of the 4 controls laid eggs. Four other adult females each received four transplants of anterior pituitary over a period of four weeks, approximately one transplantation a week, beginning November 22. Of this group, one individual deposited 28, another 23, and another 9 eggs. There were 3 controls in this series. Six specimens each received one single transplant on January 2, and one double (2 entire pars anterior) transplant on January 4. Of these, one female laid 25, one 23, and one 3 eggs. Seven individuals received one double transplant each on January 4, and within 48 hours one animal laid 17 eggs and two more 36 and 15, respectively. Four individuals each received six transplantations of anterior pituitary, one a week beginning Novbemer 20, but none of this group laid eggs. The failure of the last series to respond may be accounted for by assuming that the movements of the salamander displaced the graft or that the transplant was too rapidly absorbed in these cases. Wolf (1929) found considerable irregularity in the response of *Rana pipiens* to anterior pituitary transplants. The fact, however, that a large percentage of females do lay eggs after one or more transplantations, while none of the controls or untreated animals respond, is definite evidence of the effect of anterior pituitary substance on the ovulation of both frog and salamander.

Wolf (1929*a*) found that transplanting the anterior pituitary into adult male *Rana pipiens* in the fall induced the sexual activity of that sex. It has been shown by Noble and Weber (1929) that courtship in *Eurycea bislineata* normally takes place in the fall and hence experiments with the male were not attempted. The female *E. bislineata* picks up the spermatophores in the fall and the spermatheca during this period is frequently full of spermatozoa. Hence, eggs laid in the fall induced by pituitary transplants would presumably develop normally, although our experiments have not been carried far enough to establish this point.

The females of *E. bislineata* receiving the transplants were kept in large crystalizing dishes, each provided with a flat stone raised on smaller stones a centimeter or less from the bottom of the dish. Each dish was filled with water to a depth of two centimeters. In nature, the species breeds in brooks, attaching its eggs to the under side of stones, usually in running water. The artificial character of the breeding dishes did not prevent the egg-laying from proceeding normally. The eggs were attached singly to the underside of the flat stone, the female moving to a new position after each egg was deposited. In a few cases the animal crawled to the top of the rock for two or three minutes between the laying of each egg. The entire process occupied about one hour. Generally the eggs were attached near the edge of the rock, the tail of the female curling out and up over the edge. The actual laying of each egg required from one to two minutes and was accomplished by the animal pressing the cloaca against the surface of the rock.

The fact that normal egg-laying of salamanders may be induced in the laboratory by anterior pituitary treatment should be of considerable interest to students of amphibian life histories. There are a number of species whose egg-laying has never been described. Adults of these species may be collected frequently. If these species are subjected to anterior lobe treatment it is presumed from our experiments on *Eurycea bislineata* that egg-laying may be induced and will proceed normally if facilities are provided.

CONCLUSIONS

The transplantation of one or more anterior pituitaries in *Eurycea bislineata* induces egg-laying several months before the normal breeding season.

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AMERICAN MUSEUM NOVITATES

Number 397 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Jan. 18, 1930

59.57,99 (78.8)

BEES FROM MESA VERDE, COLORADO, IN THE AMERICAN MUSEUM OF NATURAL HISTORY

BY T. D. A. COCKERELL

Last summer Mr. Paul Franke collected 27 species of bees in the Mesa Verde National Park, and to my astonishment, nine of these proved undescribed. The new species belong to *Andrena* (six), *Nomada* (one), *Anthophora* (one), and *Emphoropsis* (one). In view of these results, and the isolation of the locality from other well-collected regions, it has seemed advisable to make a report on a number of species from Mesa Verde obtained by Dr. F. E. Lutz several years ago. Dr. Lutz sent me 55 specimens and informed me that in addition to these there are in the Museum, obtained during his expedition, specimens of the following from Mesa Verde. Most of these were identified by me at various times, except the Anthidiinæ by Mr. H. F. Schwarz, and *Bombus* by Dr. Lutz.

Agapostemon texanus Cresson
Perdita lacteipennis Swenk and Cockerell
Diadasia diminuta Cresson
Tetralonia cordleyi Viereck (variety)
Melissodes aurigenia Cresson (typical and variety with rather dark flagellum)
Melissodes grindeliæ Cockerell
Melissodes confusa Cresson
Melissodes dagosa Cockerell
Osmia wilmattæ Cockerell
Lithurgus apicalis Cresson
Anthidium placitum mesaverdense Schwarz
Anthidium mormonum pecosense Cockerell
Dianthidium ulkei Cresson
Bombus appositus Cresson
Bombus huntii Greene
Bombus morrisoni Cresson

The altitude at which the following were collected was, except as noted, about 7500 feet.

Ceratina neomexicana Cockerell, 1 female, July 3–7.

Ceratina nanula Cockerell, 3 females, July 3–7. H. S. Smith, in his table of *Ceratina*, separates *C. nanula* females in part by the clear wings. In typical specimens, from the Mesilla Valley, New Mexico, this holds. In these northern mountain specimens the wings are more dusky. It is possible that, when males from both regions can be dissected, characters will be found indicating the existence of a third species, but at present this cannot be affirmed. The female *C. nanula* is about the size of male *C. neomexicana*.

Chelostomopsis lutzi, new species

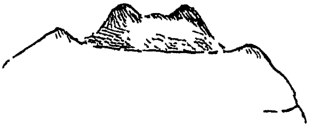
FEMALE.—Length about 6.5 mm., anterior wing, 4 mm. Robust, with very large head, which is considerably larger than thorax; abdomen broad. Head and thorax black, closely and distinctly punctured; pubescence white, very dense and snow white along each side of face, next to eyes; long white hair on anterior and posterior margins of mesopleura; dense white hair above tubercles, and at sides of metathorax, and a band in scutello-mesothoracic suture, failing laterally. Mandibles broad, black, tridentate, the apical margin very faintly reddish; clypeus shining but closely punctured, with a transverse depression, the median apical process stout but rather short; flagellum very obscurely reddish beneath; cheeks very broad and rounded. Tegulæ light rufotestaceous; wings hyaline, stigma black, nervures fuscous; basal nervure falling considerably short of nervulus (the distance about equal to half of nervulus); first recurrent nervure joining second cubital cell far from the base (the distance about equal to two-thirds of intercubitus), but the second only about half as far from apex; outer side of second cubital cell bulging. Legs mainly black, with white hair (yellowish on inner side of tarsi); hind femora swollen, very bright ferruginous. Abdomen with narrow but very distinct white hair-bands, and the last tergite covered with white hair, as well as the one before to a considerable extent; punctures of tergites very distinct; the lateral thirds of the tergites are bright ferruginous (the base also of first), as far as the fourth, on the fifth the red is reduced; ventral scopa entirely white.

Mesa Verde, Colorado, July 3–7, 1919.

Nearest to the Californian *C. australis nanus* Cockerell, but smaller, with much more red on abdomen and clypeus less densely punctured. The genus is new to Colorado.

Hoplitis mesæ, new species

MALE.—Length about 8.5 mm., anterior wing about 5.8 mm., width of abdomen about 2.5. Black, with scanty white pubescence (the type is worn), long, dense and pure white at sides of face and on apical part of clypeus; mandibles black, the cutting edge oblique, strongly tridentate, the inner tooth small; clypeus minutely and excessively densely punctured, the margin straight; third antennal joint conspicuously longer than fourth, but not so long as fourth and fifth combined; flagellum rather short, bright ferruginous beneath, except at extreme base; cheeks broad and rounded, finely punctured, shining; front dull, more shining at sides, a fine groove next to orbital margin, and next to this (mesad) a smooth band. Parapsidal grooves very short but linear. Mesothorax and scutellum shining, finely but not very densely punctured; sides of thorax shining but well punctured. Tegulæ dark brown, with weak punctures; wings short, hyaline, faintly stained with brown, especially in and about end of marginal cell; nervures black, stigma very small; basal nervure meeting nervulus; recurrent nervures ending about equally distant from and not close to base and apex of second cubital cell. Legs black, dull ferruginous apically, hair on inner side of tarsi reddish; claws strongly bidentate; pulvilli well developed; spurs dark. Abdomen shining, very minutely and not densely punctured; hind margins of tergites rufescent; first sternite with an obtuse elevation or tubercle, not very large; sixth tergite with apical corners prominent, seventh with a pair of short lobes, the broad interval between them slightly convex in middle. Genitalia small and delicate,



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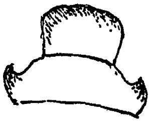

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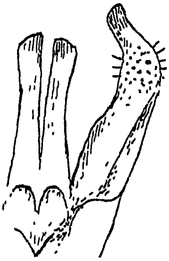

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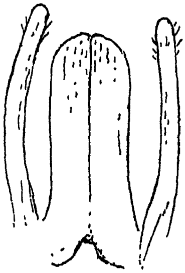

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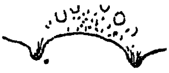

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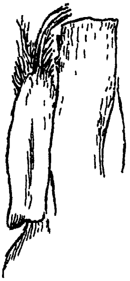

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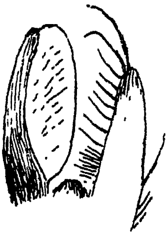

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Fig. 1. Caudal end of *Hoplitis mesæ*, new species.
Fig. 2. Caudal end of *Hoplitis adunca* (Panzer).
Fig. 3. Genitalia of *Hoplitis mesæ*, new species.
Fig. 4. Genitalia of *Heriades carinatus* Cresson.
Fig. 5. Clypeal margin of *Heriades carinatus* Cresson.
Fig. 6. Genitalia of *Colletes grisescens*, new species.
Fig. 7. Genitalia of *Colletes geranii* (Cockerell).

entirely pale ferruginous, the sagittæ straight, strap-shaped, the claspers stout, curved, with dark points and short bristles subapically.

Mesa Verde, Colorado, July 3–7, 1919.

I figure the caudal end of *H. adunca* (Panzer), the type of *Hoplitis*, for comparison. It will be seen that it is similar in principle yet very different in details. The flagellum of male *H. adunca* is distinctly compressed and broadened in the middle, which is not appreciably true of our insect. A male from California (Coffee Camp, June 11, collected at *Lotus glaber* by Timberlake), which is supposed to belong to *H. sambuci* Titus, has the caudal end like that of *H. adunca* and the flagellum modified. It also has a large thick scape, while the scape of the Colorado insect is quite ordinary. *H. truncata* (Cresson), from Georgia, also has the caudal end of the *H. adunca* type. *H. graceæ* Cockerell, from Sterling, Colorado (out on the plains), has tridentate mandibles, and the flagellum is ferruginous beneath. It is known from the female only, but differs in several respects from the species now described, and lives in a wholly different environment, so, I think the two cannot be sexes of one. In *H. mesæ* the distance from end of first recurrent nervure to first intercubitus is about half length of latter; in *H. graceæ* it is much more than half.

We must conclude that *H. sambuci* and *H. truncata* are veritable *Hoplitis;* but *H. graceæ* and *H. mensæ* form a group apart, which can be better diagnosed when both sexes of both species are known.

Heriades carinatus Cresson, 2 males, 1 female. I figure the genitalia of one of the males, and also the clypeal margin as seen obliquely from above. From another view, more directly in front, the clypeal margin appears straight, with a median semicircular depression beset with minute hairs. The case is similar to that of *Osmia californica* Cresson, in which the difference in the two aspects resulted in the synonymous name *O. pascoensis* Cockerell, as I learn from Miss Sandhouse.

Colletes grisescens, new species

MALE.—Length about 8 mm., anterior wing 6 mm. Black, rather slender, with narrow abdomen; hair of head and thorax very long, erect, grayish white, with a few long black hairs along inner orbits, but no black on thorax. Mandibles black, reddish at extreme tip; malar space about or almost twice as broad as long, minutely striate; labrum with a pair of curved (semilunar) sulci; face broad and head short; clypeus dull, very minutely punctured; antennæ ordinary, thick, reaching about to hind margin of mesothorax, flagellum very faintly brownish beneath; middle flagellar joints longer than broad; third antennal joint about as long as fourth, and the fifth very little longer; eyes dark brown; vertex at sides rather broad and flattened, very minutely punctured, somewhat shining. Mesothorax polished and sparsely punctured on disc, otherwise dull; no visible prothoracic spines; base of metathorax coarsely rugosoplicate, the rugæ close together; mesopleura dull, with a broad shining elevation on upper part. Tegulæ very dark; wings strongly brownish; nervures and stigma dark brown; basal nervure falling short of nervulus; second cubital cell receiving recurrent nervure at middle. Legs black, with dull white hair. Abdomen shining, with excessively minute, sparse, piliferous punctures; depressed hind margins of tergites brown, with rather narrow grayish-white hair-bands; first two tergites with thin long erect hair; no band at base of second. Genitalia of the type of the European *C. fodiens* Kirby (Morice, 1904, Trans. Ent. Soc. London, Pl. VII, fig. 12). The middle joints of hind tarsi might be described as campanulate, about as Morice figures for *C. fodiens.*

Mesa Verde, Colorado, July 3–7, 1919, altitude 6600 ft.

In the Rocky Mountain fauna it appears to fall close to *C. paniscus* Viereck, which has dark hind spurs (in our species they are dusky reddish), and "wings hyaline, somewhat brownish," while the sculpture is evidently different. In my table it runs near *C. gypsicolens* Cockerell, which it does not closely resemble.

Colletes geranii (Cockerell), male, July 3–7, at *Sphæralcea coccinea.* I cannot separate this from *C. geranii*, which occurs at Boulder, Colorado, in the middle of June. I figure the genitalia of the Mesa Verde specimen; the structure is similar to that of *C. chobauti* Pérez, from France. I described *C. geranii* as a race of *C. salicicola* Cockerell, which occurs in New Mexico, but I now doubt the relationship. On the other hand, Gibson and Criddle (Canadian Ent. Record for 1919, p. 21) record *C. phaceliæ* Cockerell from Manitoba and Alberta, and consider *C. geranii* to be its male. On comparison, *C. geranii* differs from *C. phaceliæ* by the very pure white (not yellowish tinted) hair of thorax above, and much more shining abdomen. I am thus left in doubt as to the true female to associate with *C. geranii.*

The following table separates the similar light-haired females.

1.—Stigma pale yellowish with very dark margin; clypeus highly polished and sparsely punctured, not striate, and with no median sulcus. *petalostemonis* Swenk.
Stigma much darker, deep rufous; clypeus striate or depressed in middle.....2.
2.—Second cubital cell very broad, receiving recurrent nervure about middle; clypeus coarsely sculptured, conspicuously striate, and depressed in middle. *phaceliæ* Cockerell.
Second cubital cell narrower, receiving recurrent nervure considerably beyond middle; clypeus sparsely but strongly punctured, depressed in middle, but not striate.................................. *salicicola* Cockerell.

C. salicicola flies early in May, at Las Cruces, N. M. On the character of the second cubital cell, *C. geranii* would go with *C. phaceliæ,* not with *C. salicicola.* Both *C. geranii* and *C. phaceliæ* were published in

1906; the former in May (type-locality, Boulder), the latter in March (type-locality, Ward).

Halictus (Seladonia) meliloti Cockerell, 18 females, July 3–7, at *Pentstemon coloradensis, Sphæralcea coccinea,* and *Calochortus gunnisonii.*

Halictus farinosus Smith, 6 males, July 3–7, altitude 6600 ft. This is a species characteristic of the Pacific coast region.

Halictus niger Viereck, 6 females, July 3–7, at *Calochortus gunnisonii.* This is very close to *H. cooleyi* Crawford, and easily confused with it, but is smaller, with duller mesothorax.

Halictus sisymbrii Cockerell, 1 female, July 3–7, at *Calochortus gunnisonii.*

Halictus trizonatus Cresson, 3 males, July 3–7, altitude 6600 to 7900 ft.

Halictus heterorhinus, new species

FEMALE.—Length about 9 mm., anterior wing, 7.4 mm. Black, with the middle and hind tarsi dusky red, but the hind tibiæ black. Hair of head and thorax rather short, dull whitish, with a perceptible yellowish tint. Face very broad; clypeus short and transverse, the lower half polished, the upper half dull and granular, the middle with a distinct broad sulcus; sides of face somewhat glistening, perhaps very slightly metallic; supraclypeal area broad, with a dull minutely sculptured surface, but a smooth polished band on each side of it, extending down sides of clypeus; front dull; flagellum thick, obscurely brown beneath. Mesothorax dull, minutely and as closely punctured as possible, except on the posterior disc, where it is moderately shining, and the punctures are more separated; scutellum shining, closely and distinctly punctured, with a median sulcus; area of metathorax large, entirely dull, with very fine sculpture; posterior truncation dull, not defined at sides. Tegulæ large, black, with a hyaline border anteriorly; wings long and ample, strongly reddened; stigma large, ferruginous; nervures pale ferruginous; third cubital cell large and broad. Legs with pale hair; hind spur not pectinate. Abdomen dull, hind margins of tergites black; bases of tergites 2 to 4 with very broad dense bands of creamy-tinged felt-like tomentum. Under the microscope the supraclypeal area shows a minutely lineolate surface, with a few large scattered punctures; the front is excessively densely punctured.

Mesa Verde, Colorado, July 3–7, 1919.

Most nearly allied to *H. cyaneiceps* Cockerell, but distinguished by the longer, reddened wings, and the red middle and hind tarsi, and the broader hind basitarsi. The dull supraclypeal area and short clypeus distinguish it from most of the related species. It belongs to the subgenus *Curtisapis* Robertson.

Halictus pulveris, new species

FEMALE.—Length about 6 mm., anterior wing 5 mm. Black, rather slender, with abdomen relatively narrow (width 2 mm.). Hair of head and thorax scanty, dull white, abdomen without hair bands or patches, but covered with fine thin pruinose pubescence. Facial quadrangle much longer than broad, clypeus projecting; mandibles with apical half bright castaneous; clypeus shining, with distinct but sparse punctures, upper part minutely sculptured and with smaller punctures, lower part polished; supraclypeal area shining, with small sparse punctures; front excessively densely punctured, shining at sides of lower part; flagellum dull red beneath; cheeks with long white hair. Mesothorax dullish, more shining laterally than in middle, finely punctured, the punctures on disc, except in middle line, well spaced; no evident median groove; scutellum shining, finely punctured, without a median sulcus; area of metathorax large, dull, finely reticulate in middle, striate at sides, with an obtuse shining rim posteriorly; posterior truncation small, shining, with no sharp lateral borders. Tegulæ clear testaceous; wings hyaline, strongly iridescent; stigma large, light fulvous, nervures pale testaceous. Legs black, tarsi red at apex; spurs ferruginous, hind spurs with a few stout teeth or spines. Abdomen shining, very finely punctured, hind margins of tergites dark rufescent; first tergite with excessively minute punctures (visible under microscope), the middle polished and almost wholly impunctate; second and third tergites with very minute, fairly close punctures.

Mesa Verde, Colorado, July 3–7, 1919, altitude 6600 ft.

The following table compares this species with its allies.

1.—Front, below the ocelli, highly polished and shining; tarsi reddish brown; hind margins of tergites pallid.
arizonensis Crawford (*vanduzeei* Sandhouse and Cockerell.[1]
Front, below the ocelli, dull..2.
2.—Tarsi pale red; head broad; margins of tergites colorless..*subobscurus* Cockerell.
Tarsi dark, at most red at tips....................................3.
3.—Clypeus short, dull, shining only at apex; abdomen broad; area of metathorax with vermiform rugæ..............................*foxii* Robertson.
Clypeus produced, shining..4.
4.—Abdomen slender; tegulæ clear testaceous.............*pulveris* Cockerell.
Abdomen broad; tegulæ dark rufous..................................5.
5.—Hind margins of tergites conspicuously pallescent; stigma clear pale fulvous; second and third tergites dull....................*synthyridis* Cockerell.
Hind margins of tergites at most faintly rufescent; stigma dusky; second and third tergites shining..............................*vaporellus* Cockerell.

Four males (Mesa Verde, July 3–7, 6600 ft. and 7300 ft.) are provisionally referred to *H. pulveris.* They are about 5 mm. long, very slender; antennæ very long, the flagellum ferruginous beneath; mandibles apically yellow (the end of the black area cuneate); labrum honeycolor; clypeus strongly produced, beset with thin grayish-white hair, and having an apical yellow band; front dull; mesothorax and scutellum shining, the latter highly polished; sculpture of area of metathorax weak; tubercles with lower half reddish; tegulæ clear testaceous; wings quite clear; tarsi very pale reddish, and also anterior tibiæ at base and apex; abdomen shining; thinly hairy. The fourth antennal joint is about twice as long as the third. In Robertson's table it goes to *H. foxii.* In Crawford's table (1907), *H. foxii* is said to have antennæ short, hardly reaching the tegulæ; he seems to have had the wrong male, as Robertson refers to the long antennæ.

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[1] Miss Sandhouse informs me of this synonymy, remarking that the abdomen of *H. arizonensis* is much less red than the description suggests. The reddish color described by Crawford is not at all present in the cotype of *H. vanduzeei* before me, so I am left rather perplexed.

Halictus (Chloralictus) pruinosiformis Crawford, 1 female, at *Pentstemon coloradensis.* This widely distributed species varies in color. The present specimen has the mesothorax shining yellowish green.

There are three other species of *Chloralictus*, represented by single specimens, two females and a male. I have not tried to work these out, as Mrs. Ellis described eight and Miss Sandhouse 22 species of this group from Colorado, not to mention numerous others from different parts of North America. The types of all these are in the U. S. National Museum, though formerly belonging to my collection. I understand that Miss Sandhouse will eventually present a new revision of the group.

AMERICAN MUSEUM NOVITATES

Number 398 Published by The American Museum of Natural History New York City Jan. 18, 1930

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SOME TINGITIDÆ (HEMIPTERA) FROM BRAZIL

By Carl J. Drake

In recent months there have come into the author's hands several collections of Tingitidæ from South America for study and identification. This paper is based almost entirely upon a small collection of lace-bugs belonging to The American Museum of Natural History, all of which were collected in Brazil, South America, by the late H. H. Smith and his wife. Thanks are due to that Museum for the privilege of studying this collection of 63 specimens representing 21 species, three of which are described herein as new. One of these new species, *Leptopharsa perbona*, is represented by eight specimens, six of which are from the Carnegie Museum, Pittsburgh, Pennsylvania.

Monanthia figurata, *Corycera comptula*, *Tingis americana*, *Leptobyrsa elegantula*, *Leptopharsa* (*Gelchossa*) *magnifica*, and *Dicysta hollandi* bear identical locality, date and collector labels as the type specimens of these species and, no doubt, represent specimens from the type series in the Carnegie Museum.

Monanthia figurata Drake.—Four males, Chapada, April.

Monanthia parmata Distant.—Male and female, Chapada, November.

Teleonemia prolixa Stål.—Two males and two females, all belonging to var. *a* Champion as described in 'Biologia Centralia Americana,' Chapada, May.

Teleonemia limbata Stål.—Male and three females, Chapada, March–June.

Teleonemia brevipennis Champion.—Female, Corumbá, April.

Teleonemia longicornis Champion.—Three males and female, Chapada, May–September.

Tigava notabilis Stål.—Two males and two females, Chapada, April.

Sphærocysta inflata Stål.—Male and female, Chapada, April–May.

Corycera comptula Drake.—Male, Chapada, September.

Tingis americana Drake.—Female, Chapada, October.

Tingis corubiana Drake.—Female, Chapada, November.

Acanthocheila armigera Stål.—Two males and female, Chapada, November.

Leptocysta sex-nebulosa Stål.—Three males, Corumbá, May.

Corythaica monancha Stål.—Male and female, Chapada, January.

Leptobyrsa elegantula Drake.—Male and three females, Chapada, March–June.

Leptopharsa (Gelchossa) magnifica (Drake).—Male and female, Chapada, January.

Dicysta hollandi Drake.—Two females, Chapada, August.

Dicysta vitrea Champion.—Female, Chapada, August.

Leptopharsa perbona, new species

Elongate, rather broad. Antennæ very long, slender, testaceous, first and second segments slightly brownish, the fourth dark fuscous. Segment I long, slightly attenuated beyond the middle, almost three times as long as two, the latter short; III very long, three times as long as four; IV very long, longer than one and two taken together. Rostral channel open behind, the laminæ widely separated on the meso- and metasternum; rostrum extending almost to the end of the mesosternum. Head, reddish brown to black, the basal portion covered by hood; median spine long, rather stout, porrect; other spines greatly reduced or wanting. Bucculæ moderately broad, closed in front.

Pronotum black, very coarsely pitted, considerably swollen, apex of triangular portion reticulate and testaceous. Lateral carinæ considerably raised, long, testaceous, parallel, in front widely separated from the sides of the hood, each composed of a single row of areolæ. Median carina more strongly raised, about one-half as high as the hood, faintly arched, composed of a single row (sometimes one or two cells divided) of rectangular areolæ. Paranota moderately large, strongly reflexed, with three rows of moderately large areolæ, the margin rounded. Hood moderately large, its length and height subequal, moderately inflated, projecting anteriorly to near the middle of the eyes. Elytra widening posteriorly, their tips rounded and widely separated; costal area broad, widely reticulated, triseriate along basal portion, with five or six areolæ at its widest part, the lateral margin finely serrate; subcostal area fuscous, almost vertical, finely reticulate, with five to six rows of areolæ; discoidal area moderately large, about one-third as long as elytra, narrowly rounded at base, with five or six rows of areolæ at its widest part, the basal half fuscous. Areolæ of elytra, paranota, hood and carinæ hyaline. Wings slightly longer than abdomen. Legs very long, slender, brownish testaceous, the tips of tarsi darker. Body beneath black. Reticulation of hood, carinæ, paranota, and elytra mostly testaceous; those of discoidal, subcostal, basal portion of sutural areas, and two or three transverse nervures of costal area and also an oblique fascia (composed of one row of areolæ at base and gradually widening to two or three at apex and also nervelets) on apical portion of each elytron fuscous.

Length, 4.21 mm.; width, 1.98 mm.

Holotype (male) and Allotype (female): Chapada, Brazil, H. H. Smith, in Carnegie Museum, Pittsburgh, Pennsylvania. Paratypes: six taken with type; two in American Museum of Natural History, two in Carnegie Museum, and two in my collection.

This species has the extremely long basal antennal segment as in *L. vesiculosa* (Champion) and *L. longipennis* (Champion) but differs markedly in the structures of the pronotum, paranota, and elytra.

Leptopharsa iridis, new species

Elongate, widening behind. Antennæ extremely long, slender; segment I extremely long, attenuated beyond the middle, black-fuscous, almost five times the length of two; II short, brown to fuscous; III long, slender, testaceous, two and two-thirds times the length of one; IV very long, fuscous, five-eighths the length of three and considerably longer than one and two conjoined. Rostral sulcus open behind, widely separated on meso- and metasternum, the rostrum extending almost to the end of the sulcus. Legs long, slender, brownish testaceous, the tarsi fuscous.

Pronotum black, considerably swollen, coarsely pitted. Paranota very strongly reflexed, turned back over the outer margin of pronotum, bi- to triseriate, the areolæ moderately large. Hood rather large, slightly compressed, extending anteriorly to the front margin of head, the eyes exposed, the median dorsal nervure fuscous. Median carina very strongly elevated, as high as hood, composed of one row of very long rectangular areolæ, a few of the areolæ divided. Lateral carinæ not so strongly elevated, slightly constricted behind the middle, composed of a single row of moderately large areolæ, in front not widely separated from the sides of hood. Elytra strongly widening posteriorly, their tip very widely separated; costal area broad, widely reticulated, biseriate at base, triseriate at widest point; subcostal area finely reticulated, mostly biseriate, almost vertical, discoidal area rather small, narrowed at apex, with three to four rows of areolæ at its widest point. Areolæ hyaline; nervures largely testaceous; those of discoidal, subcostal, basal portion of sutural area and an oblique fascia (including a row of areolæ) on distant half of each elytron fuscous. Wings a little longer than abdomen, smoky. Body, black, claspers strongly curved in male.

Length, 3.80 mm.; width, 1.41 mm.

HOLOTYPE (male) and ALLOTYPE (female): Chapada, Brazil, in American Museum of Natural History. PARATYPES: two taken with type in author's collections.

This species is most closely allied to *L. vesiculosa* Champion.

Gargaphia dissortis, new species

Moderately elongate, broad. Head reddish brown, with five long, slender, sharp testaceous or brownish spines, the median and posterior pair very long. Rostrum reaching almost to the transverse laminæ of the rostral sulcus; eyes black. Antennæ long, slender; segment I stout, rather long, distinctly curved, ferruginous, about three times as long as two, the latter slenderer; III brownish testaceous, long, less than three times as long as four; IV fuscous, slightly longer than one and two conjoined. Pronotum considerably swollen, black, the apical portion of the triangular projection reticulate and testaceous. Lateral carinæ strongly raised, slightly curved inwardly, each composed of a single row of large areolæ; median carinæ a little more elevated, faintly arched in front of middle. Hood small, strongly compressed, faintly projecting anteriorly, arched above, with three rows of areolæ on each side. Paranota rather broad, distinctly angulate behind the middle, slightly reflexed, mostly biseriate, tri- or quadriseriate at angle; areolæ moderately large.

Elytra broad, the outer margin finely serrate, their tips broadly rounded and separated; costal area very broad, mostly irregularly quadriseriate, with five or six rows of areolæ at its widest part, with four or five of the transverse nervures enlarged and dark fuscous; subcostal area bi- or triseriate; discoidal area large, broadest behind the middle, broad and somewhat obliquely rounded at apex, with five or six rows of areolæ at widest part; veinlets in distal half embrowned. Reticulations largely testaceous, some brown or fuscous; areolæ hyaline. Legs pale brown, the tarsi fuscous. Wings slightly longer than abdomen.

Length, 3.41 mm.; width, 1.62 mm.

HOLOTYPE (male) and ALLOTYPE (female): Chapada, Brazil, in American Museum of Natural History. PARATYPES: two males and two females, taken with type; two in American Museum of Natural History and two in author's collection.

AMERICAN MUSEUM NOVITATES

Number 399 | Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City | Jan. 23, 1930

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A RARE SPIDER CRAB FROM CALIFORNIA
(*MITHRAX ROSTRATUS* BELL)

BY LEE BOONE

Among the Crustacea recently received by The American Museum of Natural History from the Brooklyn Museum, when the latter institution discontinued its collection of invertebrate zoölogy, there is an unusually large and perfect male specimen of the rare spider crab, *Mithrax* (*Mithrax*) *rostratus* Bell, hitherto known only from the type specimen which is no longer extant, described and figured by Thomas Bell in 1836, without specific locality, from among a lot of 'Crustacea of the Coasts of South America.' Dr. Milne Edwards suggested that the type may have come from the Galápagos; presumably because a number of Bell's species were from that locality. It is not improbable that this species may be found from Southern California to Peru, or even Chile, and also in the Galápagos Islands. The fact that Bell's type was a comparatively small specimen, without definite locality, and that it has not been taken again during the almost century which has elapsed, despite the extensive dredging operations of the 'Beagle,' 'Challenger,' 'Albatross,' 'Arcturus,' 'Ara,' 'Pawnee,' and the explorations conducted by the various universities and marine biological laboratories of the West Coast, makes this indeed a valuable addition to the Museum collection.

It is the western American analogue of the West Indian giant red spider crab, *Mithrax* (*Mithrax*) *spinosissimus* (Lamarck), which is known in the Antilles as the "Cangrejo de la Santa Virgin" because of the native belief that an outline of the Madonna and Child are faintly designed on the back of the crab by the arrangement of spines. Whether or not *M. rostratus* attains approximately as great size as its West Indian relative, which is conspicuously the largest of the Caribbean spider crabs, cannot be ascertained definitely until more specimens are secured, but the massive size of the present specimen, which is unquestionably littoral, would indicate that *M. rostratus* probably rivals *M. spinosissimus* in size.

For the present, the coloration of *M. rostratus* must also remain in question: this specimen, which has been in preservative since 1916, retains the carmine red on those parts which customarily fade least in preserved crabs, while the parts which usually fade first are brown or brownish yellow. In this connection, it should be noted that while Bell describes his type as "lightish brown; hands mottled," his specimens had been in preservative for sufficient time to have faded, as is established by comparing the color descriptions he gives of several more common species, the actual colors of which are now known.

Mithrax rostratus Bell

Mithrax rostratus BELL, 1835, Proc. Zoöl. Soc. London, III, (1836), p. 171; 1836, Trans. Zoöl. Soc. London, II, p. 51, Pl. x, figs. 1, 1*b*. A. MILNE EDWARDS, 1875, 'Crust. Rég. Mex.,' p. 101.

Mithrax (*Mithrax*) *rostratus* RATHBUN, M. J., 1925, Bull. 129, U. S. Nat. Mus., p. 386, Pl. CLV (copy of Bell's figure).

TECHNICAL DESCRIPTION.—Male, Cat. No. 6182, A. M. N. H., collected at La Jolla, Califorina, 1916, by Dr. George P. Englehardt. Carapace 145 mm. long, including rostrum, which is 20 mm. long; maximum width 115 mm. across the cardio-branchial region. Carapace broadly pyriform, narrowed anteriorly with the post-cervical region broadly rounded; dorsal surface high, regularly convex, everywhere rough with short, stout, conical spines, as illustrated. These spines also occur on the side walls of the carapace, along the sub-hepatic and sub-branchial regions. The regions are clearly defined, the cervical and hepatic regions being sharply delimited, the grooves on the cardio-intestinal region being less accentuated. The rostral horns are strong, well-developed and deflected sharply downward from the base; they consist of a pair of triangular horns, united basally for half their length, but with a median groove for this distance on the dorsal surface, the distal half of each horn forming a long, narrow triangle, separated from each other by a triangular sulcus equal in size to one of the rostral horns. There is a strong triangular tooth at the superior preocular angle, with one or two lesser dentitions on the upper ocular margin; a very strong triangular tooth at the postorbital angle, directed forward and outward, below which there is a strong conical spine. The strong, outpointing conical spine which occurs at the external distal angle of the basal antennal joint forms the inferior preorbital angle; this joint also bears two lesser blunt tubercles, one at the external proximal angle and the other at the inner distal angle, just below the base of the second article; the second article is two-thirds as long as the first, but very slender, rod-like, compressed cylindrical, with a stiff fringe of bristles along its outer lateral margin; the third article is only three-fifths as long as the second, similarly rod-like but narrower, not reaching as far forward as the tip of the rostral horn.

The antennulæ fold almost vertically within the fossette which lies beneath the rostrum and is divided for about half its length by a sharp tooth.

The eyestalk is bulbous basally, decidedly constricted medially, narrowing a trifle distally with a tongue-like calcareous projection covering the dorsal surface of the cornea and bearing a tuft of setæ; the cornea is very small, terminal, moderately convex. The dense fur-like setæ of the postocular spine almost conceal the cornea.

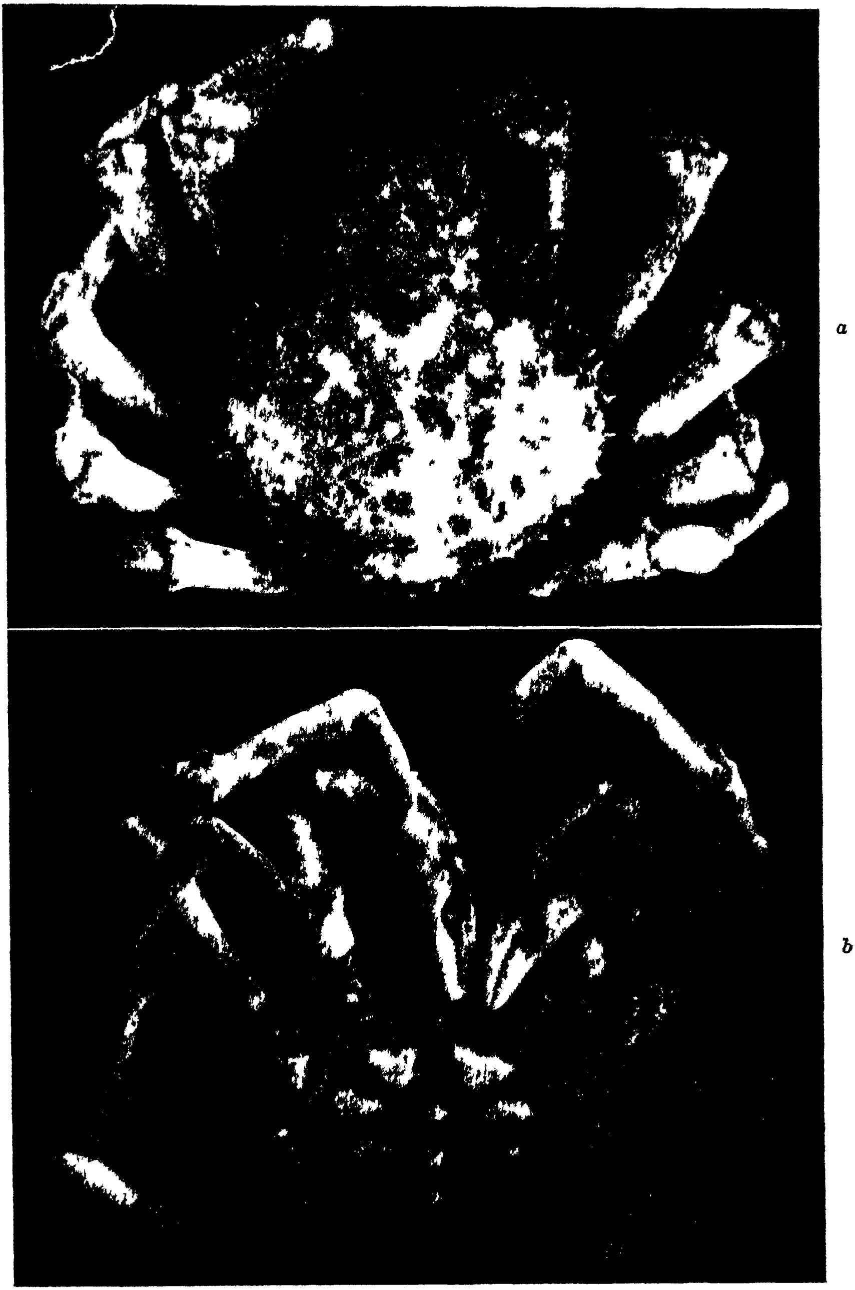

Fig. 1.—*Mithrax* (*Mithrax*) *rostratus* Bell, about one-half natural size. *a*, dorsal view; *b*, ventral view.

The external maxillipeds are densely covered with fur-like setæ; the exognath has its ischium long and slender, reaching almost to the distal angle of the buccal cavity; the whip is concealed. The ischium of the endognath is twice as long as wide with the inner distal angle produced and evenly rounded on its distal margin; the merus arises from the external distal margin of the ischium, is of irregular shape and widens distally, conforming to the contour of the buccal cavity; the inner distal angle of the merus is excavate for the reception of the small three-jointed palp which lies beside the inner margin or the merus and is heavily setose.

The sternal plastron is nearly oval, sharply ridged opposite the bases of the chelipeds and the first and second pairs of ambulatories, the depressions between these ridges and the margins of the plastron being densely tomentose. The male abdominal belt is narrowly triangular, seven-segmented, the first to sixth segments, inclusive, ridged in the middle.

The chelipeds are subequal in the male, measuring 175 mm. long; of moderate slenderness, coxa and basis strong; the ischium produced to a strong triangular process on the inner distal angle; the merus long, three-sided, widening distally, with 12 to 20 conical spines on the upper surface, most of which are on the distal part; the carpus is short, convex on the upper surface and covered with uneven conical spines; the propodus is slightly more than one and one-half times as long as the merus, the palm comprising two-thirds of the total length and being one-half as high on the outer face as long, convex, smooth, with a setose longitudinal depression just below the upper margin on the outer face; there are a number of conical tubercles proximally on the upper margin of the palm. The propodal finger is about half as long as the palm, narrow, curved downwards, with 12 or 13 ordinary blunt teeth; the hinged finger is more curved than the propodal, upon which it closes throughout the distal half of its length, which is armed with 12 or 13 low teeth; proximally there is an elliptical gape, midway of which there is a large molariform tooth.

The four pairs of ambulatory legs are similar, strong, successively decreasing in length posteriorly, the first pair exceed the length of the chelipeds by nearly an inch, the third, fourth and fifth pairs of legs each have the tip of the dactyl reaching to three-fourths the length of the preceding leg. Each leg has the basal articles strong, tomentose; the merus long, subcylindrical; the carpus nearly half as long as the merus, slender, subcylindrical, produced on the hinder lateral distal margin into a rounded lobe which projects onto the dactyl and strengthens this joint; the dactyl is strong, curved, about three-fourths as long as the propodus, densely tomentose except for the sharp, horny nail-like tip by means of which the crab obtains a grip on the rocky sea-bottom.

AMERICAN MUSEUM NOVITATES

Number 400 Published by The American Museum of Natural History New York City Jan. 31, 1930

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PARASITES OF MANTIDÆ FROM NEW CALEDONIA

By T. D. A. Cockerell

The orthopteroid insects of New Caledonia (including the Loyalty Islands) show, in general, a very high degree of endemicity, as might be expected from the long isolation of the island and its remarkable flora. Thus, J. Carl, reporting on the Phasmidæ, had to establish four new genera, and seventeen species appear to be confined to New Caledonia. Chopard, in his account of the Gryllidæ, describes ten new species out of twenty-one, and proposes two new genera. The Mantidæ are known from palæontological evidence to be of enormous antiquity, so it might be supposed that they also would be numerous and diversified in New Caledonia, especially since they abound in Australia and New Guinea. As the records stand, however, there seems to be only one species, *Polyspilota* (?) *brunneriana* Saussure, 1871.

Dr. Jean Risbec, well known for his important studies of Mollusca, collected in September, 1929, a number of mantid egg-cases at Noumea, New Caledonia. The cases are attached to twigs in the usual manner; they are pale gray, quite soft, broad oval to subglobose, the larger ones about 31 mm. long and 23 mm. across. From these were bred numerous specimens, including three species, of the peculiar chalcidoids constituting the subfamily Podagrioninæ, which infest only the egg-cases of Mantidæ. These highly specialized parasites, spread over the globe whenever Mantidæ occur, must also be of great antiquity, though we know nothing of their actual history.

Ashmead (1904) recognized two genera: the wide-spread *Podagrion*, and the comparatively little-known *Pachytomus*, based by Westwood on a species from Egypt. The latter is given in Dalla Torre's 'Catalogue' as a subgenus, but it appears to be a valid genus, and I believe I am correct in referring one of the New Caledonia species to it. More recently, Girault has founded three additional genera on species from Australia. One of these, *Pachytomoides*, lacks the ring-joint of the antennæ, has the club enlarged, and the ovipositor very long. It includes three species from Queensland: two described by Masi from Formosa, and *P. greeni* (Crawford) from Ceylon. It is quite distinct from the New Caledonia species, all of which have the ring-joint.

A second genus, *Podagrionella,* contains four Australian species, and is usually recognizable by the dark markings of the wings, which are absent in all the New Caledonia forms. The third, *Pachystomoidella,* based on *P. magniclavus* Girault from Queensland, has the female antennal club enlarged and the four distal funicle joints transverse. The ovipositor is not quite as long as the body, the wings are hyaline, and the hind femora have seven large teeth. *Podagrion abbreviatum,* described below, might well be referred to *Pachystomoidella,* but I doubt the validity of the genus. Crawford seems to have been of a similar opinion when he described his *Podagrion crassiclava,* a species nearly agreeing with *Pachystomoidella.*

The known species of *Podagrion* come from Europe (five), tropical Africa (one), Seychelles Islands (one), Bourbon (one), Mauritius (one), Ceylon (three), China (three), Formosa (eight), Philippine Islands (two), Japan (one), Australia (thirteen), the United States (two), and the Neotropical Region (ten). The greatest concentration of species in a small area is in Formosa. In the case of the species credited to Europe, two are really of doubtful origin, being described by Dalman without precise indication of the locality. It seems remarkable to get three quite distinct species out of one lot of egg-cases in New Caledonia. The types of these are in The American Museum of Natural History.

PODAGRION Spinola

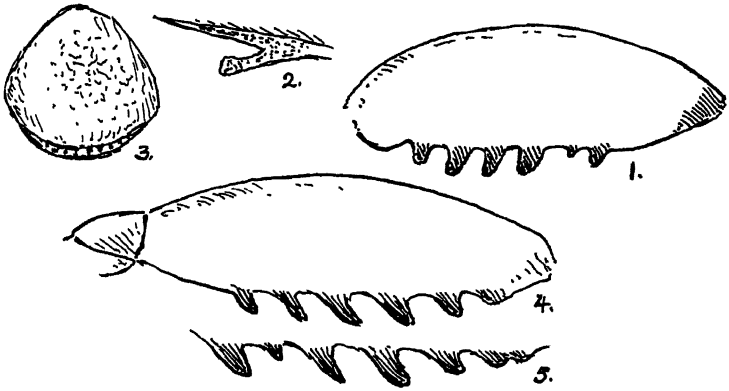
Podagrion dolichurum, new species

FEMALE (type).—Head and thorax about 1.5 mm., abdomen about 1.2 mm.; ovipositor about 6.5 mm.; face emerald-green; head and thorax above dull olive-green, scutellum shining golden-green, contrasting; metathorax dorsally bluish green; sides of thorax dull blue-green, shining golden-green above middle and hind legs; antennæ long, black; wings hyaline, venation dark; legs green, with the anterior knees, tibiæ and tarsi rufotestaceous, with the tibiæ largely dusky; middle tibiæ and tarsi very long and slender, similarly colored but rather darker; hind coxæ green, but apex and trochanters red; hind femora shining green with coppery tints, the teeth black; hind tibiæ dark, but tarsi red; abdomen shining green, coppery apically, the sides of venter rufofulvous.

Sculpture ordinary; surface of scutellum finely reticulated; metathorax with lateral carinæ but no spines; antennæ appearing 11-jointed, the club solid, slender, not enlarged, ring-joint present; hind tibiæ without angular projection on inner side; hind tarsi slender, femora with six teeth, the last sometimes double, and if not, short and broad; stigmal vein fairly long, appreciably broadened at apex.

MALE.—Length about 3 mm.; antennæ entirely black, rather stout, hairy; similar to female except for sexual characters, the abdomen ferruginous beneath near base, but otherwise entirely metallic, coppery at apex.

Three females and one male.



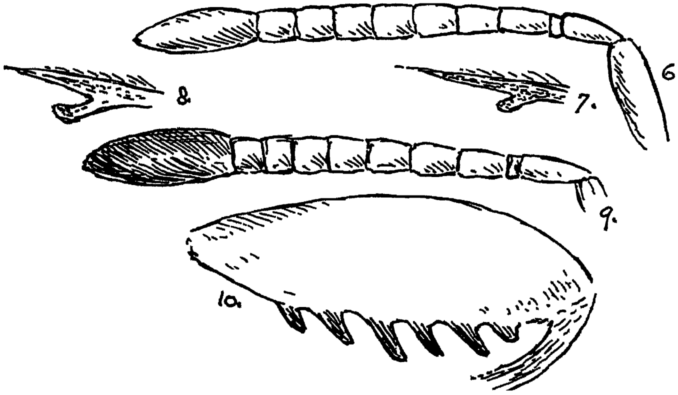
Figs. 1 to 5. *Podagrion dolichurum.*

1. Hind femur of male. 2. Stigmatic region of female. 3. Scutellum of female. 4. Hind femur of female. 5. Variation of hind femur of female.

The very long ovipositor is the most distinctive character. In the Australian *P. koebelei* Crawford, the ovipositor is even longer (8 mm.), but that is a much larger insect throughout, and the antennæ are quite different.

Podagrion abbreviatum, new species

Female (type).—Size and appearance nearly as in *P. dolichurum,* but easily distinguished by the following characters: face dull, not brilliant green; scape rufotestaceous; funicle varying from very dark brown to red, but club black; apical funicular joints short, transverse; club conspicuously enlarged; hind femora distinctly metallic (green) only on outer side; ovipositor about 4 mm. long; venation brown.

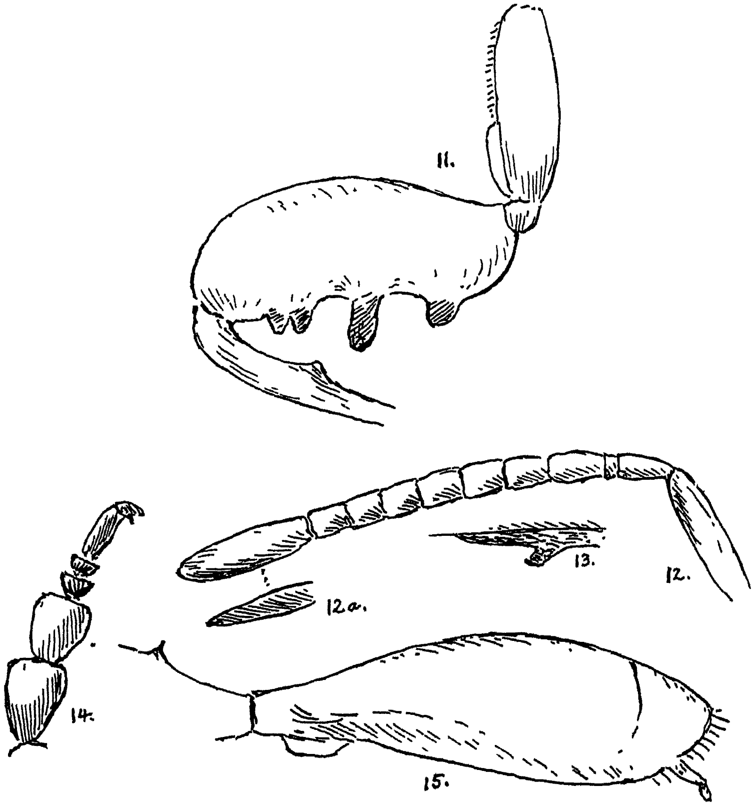


Figs. 6 to 10. *Podagrion abbreviatum.*

6. Antenna of male. 7. Stigmatic region of male. 8. Stigmatic region of female. 9. Antenna of female. 10. Hind femur of female.

Male.—Readily known from the male of *P. dolichurum* by the red antennæ, clear red anterior and middle legs, and the basal half of the abdomen dusky ferruginous. The antennal club is not swollen. The mandibles are short, black and tridentate. This sexual difference in the antennæ occurs also in the Australian *P. beneficium* Girault, and it seems very doubtful whether we should recognize the genus *Pachystomoidella* Girault, to which *Podagrion abbreviatum* might well be referred on account of the female antennæ.

Many females, and two males.



Figs. 11 to 15. *Pachytomus risbeci*. Males.

11. Hind coxa, femur, and part of tibia. 12. Antenna 12*a*. View of club from side, showing compression. 13. Stigmatic region. 14. Hind tarsus. 15. Abdomen

Pachytomus Westwood

Pachytomus risbeci, new species

Male.—Head and thorax about 1.5 mm., abdomen about 1 mm.; hind coxæ about as long as abdomen; length of insect to end of hind femora fully 3.5 mm.; head and thorax yellowish green, the face brighter, emerald-green, vertex dull and dark, thorax above dull olive-green, but scutellum brassy, and metathorax above with a bright brassy color; the middle of mesothorax is also somewhat brassy; sides of thorax bright green; antennæ rufotestaceous; wings hyaline, iridescent, the venation dark; legs rufotestaceous, hind coxæ with a large green patch on basal half externally; teeth on hind femora black; hind tibiæ very dark brown, red at extreme base and the broadened apical portion reddened; hind tarsi dusky reddish; abdomen rufotestaceous, shining green apically. Sculpture, and very sparse silvery hairs, quite ordinary; scutellum with posterior channel having large shining pits, and just above this a shining brassy pointed space; disc of scutellum finely reticulated, the reticulations more or less transverse; metathorax at each side with a small sharp spine, visible in profile; antennæ appearing 11-jointed, the club solid; ring-joint present; funicular joints fairly long, not transverse, each about 80 μ long; club about 240 μ long, not swollen, but compressed, so that in one view it appears very slender and acute; stigmal vein short and obtuse; abdomen with a short raised keel beneath near base; hind coxæ dorsally on basal half or rather more with short hairs, but on the apical portion a raised thin keel; hind femora enlarged as usual, with four teeth below, the first two very stout, the last two smaller and united; hind tibiæ with an angular projection on flexor surface; hind tarsi with first two joints very large, inclined to be quadrate, the next two small and transverse, the last elongate.

Three males.

The type of *Pachytomus* (*P. klugianus* Westwood) is from Egypt, and differs in the venation and tarsi to some extent. Possibly the New Caledonia species should form a distinct genus, but for the present it seems best to refer it to *Pachytomus*. The eyes of our species have a few very minute short hairs.